Transportation Library

The Dock & Harbour Authority

AUG 6 - 1958
UNIVERSITY OF MICHIGAN
AUG 4 1958
TRANSPORTATION LIBRARY

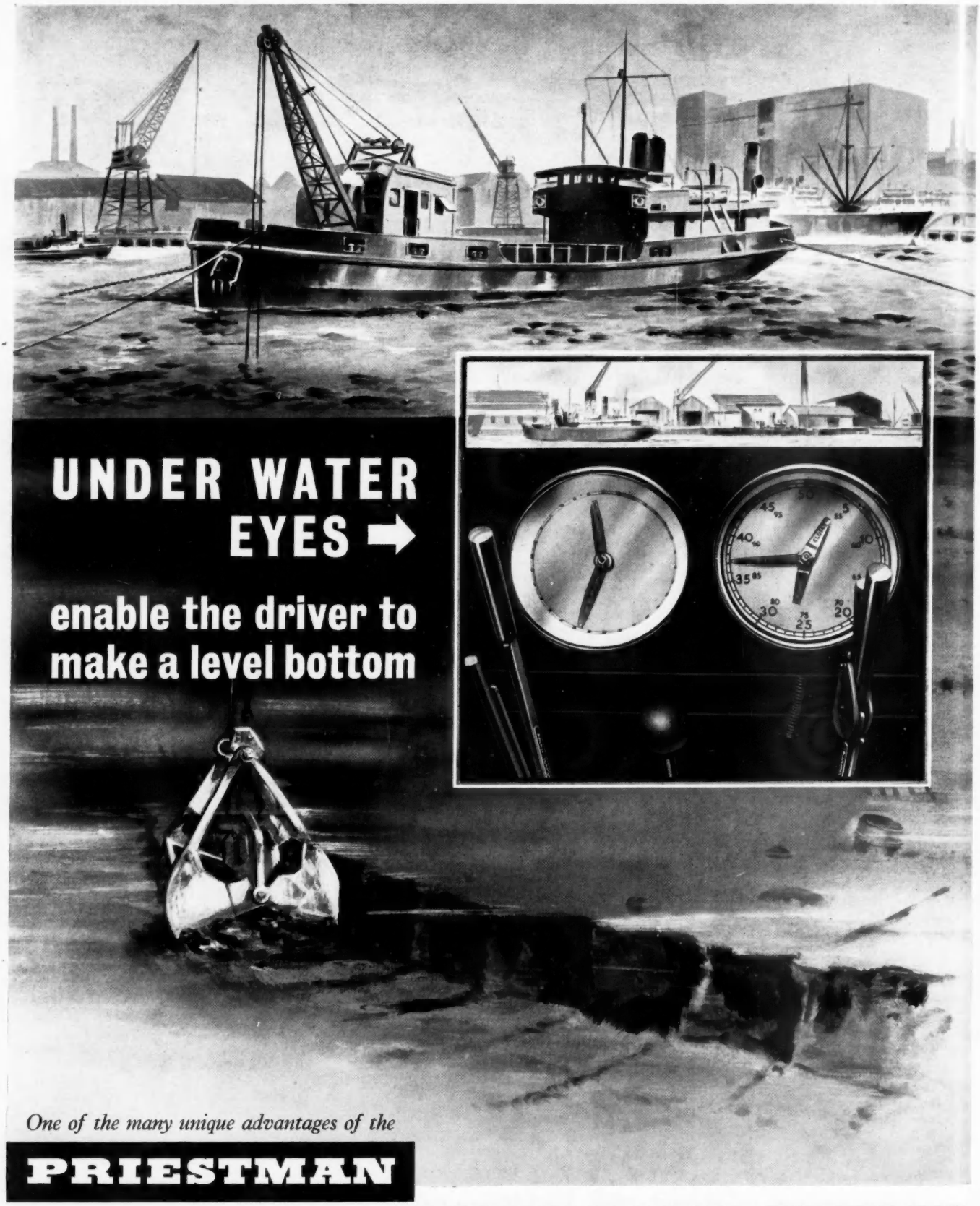
No. 453. Vol. XXXIX. JULY, 1958 Monthly 2s. 6d.

The Organisation with 3 Centuries of Dredging Experience

WESTMINSTER DREDGING CO. LTD.

12-14 DARTMOUTH STREET, WESTMINSTER, LONDON, S.W.1. Telephone: TRAfalgar 6835-7
WEST COAST: 301 New Chester Rd., Bromboro', Cheshire. Tel. Rock Ferry 2233-5
EAST COAST: Exchange Buildings, Quayside, Newcastle, 1. Tel. Newcastle 29927

Contractors to the Admiralty and Crown Agents


UNDER WATER EYES ➡
enable the driver to make a level bottom
One of the many unique advantages of the
PRIESTMAN
SYSTEM OF GRAB DREDGING
PRIESTMAN BROTHERS LIMITED, HOLDERNESS ENGINEERING WORKS, HULL, ENGLAND

The Dock & Harbour Authority

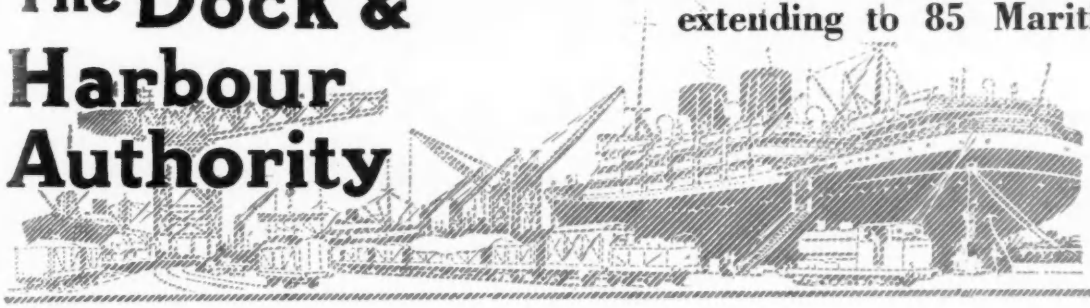
An International Journal with a circulation extending to 85 Maritime Countries

No. 453

Vol. XXXIX

JULY, 1958

Monthly 2s. 6d.



Editorial Notes

The Port of Felixstowe

Mention of the town of Felixstowe, in East Suffolk, usually calls to mind its amenities as a flourishing seaside resort; it also has some importance, however, as one of the minor ports of the United Kingdom, and during the First and Second World Wars, it rendered invaluable service as a naval base for coastal forces.

The first dock was constructed in the 1880's by the Felixstowe Dock and Railway Company and was used chiefly for the shipping of agricultural produce. Requisitioning by the Royal Navy and damage caused during the recent war, however, seriously interfered with the port's normal trading activities and the further damage sustained during the serious storm early in 1953 left the dock facilities in a practically derelict condition. These handicaps have entailed a vigorous programme of rehabilitation and the Company is to be congratulated on the enterprise and initiative with which they have overcome so many difficulties.

It is encouraging to learn that as a result of their endeavours the trade of the port has increased considerably during the past three years.

The article on a following page gives a detailed account of the civil engineering work involved in the reconstruction of the port and contains many features of technical interest.

The Port Kembla Development Scheme

Readers will recall that articles and reports describing the improvements in hand at Port Kembla have appeared in this Journal during recent years.

It has now been announced that the New South Wales State Government has placed a contract with McDonald Contractors Pty., Ltd., for the excavation of Port Kembla inner harbour at a cost of £A1,100,000. The building of the inner harbour, in what is now Tom Thumb Lagoon, will eventually cost £A15 million.

At present the Gahagan Dredging Corporation of New York, which was awarded a contract valued at nearly £A1,000,000, is removing four million cubic yards of soft sludge. It was stated in November last that rock formation had been discovered in parts of the area to be dredged and this work involves the biggest excavation of underwater rock ever undertaken in Australia. Although the time for dredging the inner harbour has been estimated at eight years, provision has been made for sufficient work to be completed by March, 1960, in order to make available two berths to be used by Australian Iron & Steel Ltd.

Work on the new contract is expected to start next September. A 250-ton dragline assembly, one of the largest in Australia, will be used to excavate the harbour bed. This equipment will be erected on a pontoon 90-ft. x 60-ft., which is to be built by the contractors and, to overcome the difficulty of drilling from a floating platform, the pontoon will be supported on the harbour bed by steel legs which can be retracted, thus enabling the equipment to be floated to new sites of operations.

The inner harbour project is designed to make Port Kembla an all-weather port. The lagoon has at present a depth of about 18-in. at low water, but the aim is to increase this depth to 32-ft. at low water.

Great Lakes Pilotage

The Great Lakes Pilotage Bill has come up for hearing before the Senate Commerce Committee in Washington. The object of the Bill is to require vessels to employ specially qualified pilots or shipmasters while navigating the Great Lakes. It has the support of many American interests, including the Organisation of Masters, Mates and Pilots (which is, indeed, one of the prime movers of the new legislation) the Coast Guard, the Pilots' Association and the Merchant Marine Institute.

Opposition comes from the Shipping Federation of Canada, which is also representing several foreign bodies, including the Chamber of Shipping of the United Kingdom, and the Chicago Overseas Shipping Association. The attitude of the American Merchant Marine Institute is summed up by the vice-chairman, Mr. Alvin Shapiro, in his submission to the Senate Committee that the increase of traffic on the Lakes with the opening of the St. Lawrence Seaway will mean that navigation in this long stretch of water may well be menaced if skilled pilots or other officers fully qualified and thoroughly knowledgeable about the waters in which they sail are not directing the navigation of these ships during the course of their voyages in the Great Lakes area.

This may appeal to many people as a piece of special pleading. In any case the fears expressed are not shared by the American State Department, which is not supporting the Bill. Because of that lack of support it is extremely unlikely that the Bill will be passed.

London Down-Graded

If United Nations statistics are to be regarded as authoritative, a little more care must be spent on their compilation—and like must be compared with like. Those associated with the Port of London Authority must have rubbed their eyes in astonishment to see in the U.N. Monthly Statistical Bulletin a table of the world's leading ports in which London is placed fourth. There may be argument as to whether London or New York has the bigger port—it depends how the limits of the two dock systems are defined—but there is cause for complaint at London being relegated in the list to a position below Hampton Roads. The explanation, on examination, is simple. In the first place, the U.N. statisticians seem to have taken the P.L.A. as embracing all the docks in London, for it is the P.L.A. figure they use; and secondly, they have excluded all coastal traffic (although the tonnage handled coastwise in every American port in the table is carefully included). Now, extensive as is the P.L.A. system, it does not include all the wharves on the river front and the cargo handled at these must be considerable. As to coastal traffic, something like 18m. tons of coal cargoes alone are discharged at the private wharves of the power stations, gas works and factories on the river. When these two factors are taken into account London's 54.4m. metric tons of cargo loaded and unloaded may well challenge comparison with the 88.0m. metric tons given for New York. In any case, the absence of these two important classes of traffic makes the U.N. figures look silly.

Editorial Notes—continued

Dock Strike in India

A national dock strike involving some 150,000 workers began in India on June 16th and ended on June 25th after the Indian Prime Minister had given his personal assurance to the dockers' leaders that their claims would receive prompt attention.

The strike, which was called by the All-India Federation of Port and Dock Workers, was the culmination of four years' negotiations by the unions for improvements in their working conditions, during which both the Government and the local ports authorities had shown a disinclination to act with any sense of urgency. The frustration which this attitude aroused among the workers came to a head with the Choudhury Report, a report by a special investigating officer into port workers' conditions, which contained a number of recommendations favourable to the dockers.

The report itself took much longer to prepare than expected and further delays took place after it was submitted to the Government last summer. The Federation had already several times postponed strike action on the assurance of the Government that it would act speedily on the report but when they were asked once again to wait—this time until July 15th—labour was withdrawn. The strike took an ugly turn with the firing by police on strikers in Madras, an incident in which six strikers were killed and many injured. The Indian Government has since announced that the incident is to be investigated.

Free Transit Area at Bahrein

On the 2nd January, 1958, the Free Transit Area at the Port of Bahrein was officially opened at a ceremony patronised by H.H. the Ruler, Sheikh Sir Sulman bin Hamad AlKhalifa. Goods now pass through Bahrein without payment of Customs duty, and it is understood that many firms have made enquiries about the allocation of premises for workshops, as well as for specialised depots, and these are under consideration.

At the beginning of 1957 the Customs and Port Area of Bahrein consisted of seven closed sheds and one open shed, with a total capacity of approximately 35,000 tons, and land reclamation was proceeding in two places in order to provide further covered storage space.

Both reclamations were completed early in the year and six Arcon sheds were erected, on one block, on the western area. The sheds have no intervening walls and form an enclosed space 200 x 360-ft. capable of holding some 25,000 tons of merchandise. Transparent plastic sheets set in the northern slopes of the gabled roof provide ample light for daytime working. Light railway lines equipped with turntables allow easy movement of goods from the stacking areas to the interior of the sheds. The southern reclaimed area has so far been left for open stacking, with capacity for approximately 5,000 tons, and this is used mainly for timber and other building materials.

Plans for 1958 have had to be restricted owing to shortage of funds. Further reclamation of land is well under way, however, and when this extension to the southern area is ready, it is planned to erect six new sheds, bringing the total storage space to 85,000 tons by the end of the year.

The mechanical equipment of the Port at present consists of one crane with a lift of 25 tons deadweight, one railway crane of 9½ tons capacity and a mobile crane of 2½ tons capacity. There are also two small fork-lift trucks in use, and a further two are on order. During 1958 a diesel-driven conveyor belt for unloading barges will be added to the equipment. The machine will be used as a supplement to the present stevedore force and will not displace any labour.

Improvements at Port Louis

The Mauritius Government recently announced a Capital Expenditure Programme totalling £15,750,000 for the social and economic development of the Island. Port developments include the harbour at Port Louis which will be greatly improved by the extension of existing quays, by the construction of more lighterage berths, and by the provision of modern Customs and warehouse facilities. The total estimated cost is about £560,000.

Proposals for St. Lawrence Seaway Tolls

According to the Congressional Information Bureau's Bulletin No. J.—876, the St. Lawrence Seaway Authority of Canada and the St. Lawrence Seaway Development Corporation of the United States have jointly announced proposals for the St. Lawrence Seaway tolls. These proposals will form the basis of recommendations to be made to their respective Governments to meet the requirements of the legislation of each country.

It is recommended that for each passage through the entire Seaway, that is from Montreal to Lake Erie, a vessel will be assessed at 6 cents per ton gross, and at 42 cents per ton of bulk cargo and 95 cents per ton of general cargo carried. For each passage from Montreal to Lake Ontario only and vice versa, the charge will be 4 cents per ton gross of the vessel, 40 cents per ton of bulk cargo and 90 cents per ton of general cargo carried. For partial transit of the new Seaway facilities between Montreal and Lake Ontario, where there are seven locks, the user will be charged 15 per cent. of the applicable toll for each lock transited. For each passage through the Welland Canal only, a vessel will be assessed at 2 cents per ton gross, 2 cents per ton of bulk cargo and 5 cents per ton of general cargo carried. In the Welland Canal a partial transit will be assessed at 50 per cent. of the toll, irrespective of the number of locks used. The unit of weight for the collection of tolls on cargo will be a ton of 2,000 lb. Commercial vessels carrying passengers will be charged 50 cents per passenger for each lock transited between Montreal and Lake Erie, in addition to the vessel charge.

Improvements at British Transport Docks

The British Transport Commission have authorised improvement schemes costing £500,000, for new quay cranage, wharf reconstruction, and the provision of two new tugs at the South Wales Ports, and £250,000 for quay modernisation at King's Lynn.

At Swansea, the West Wharf in Prince of Wales Dock, 650-ft. long, which has been out of use for some time, is to be reconstructed. Railway lines and crane tracks will be renewed and the surface paved in concrete. Four electric cranes will be transferred to the West Wharf from King's Dock and will be replaced by four new electric 6/3-ton cranes equipped for the discharge of bulk dry cargoes by grab.

For service at the Eastern ports in South Wales—Newport, Cardiff and Barry—two new diesel tugs will be provided in replacement of two steam tugs. The new vessels, which will have a length of approximately 90-ft., beam of 24-ft. and moulded depth of 11-ft., will be equipped with twin-screws and the total power of each tug will be about 900 B.H.P.

At King's Lynn, the South-East Quay, Bentinck Dock is to be modernised, including the replacement of hydraulic cranes by more powerful electric units; the resurfacing of the quay in concrete; the renewal and strengthening of the crane tracks; and new and improved railway layout.

Water Pollution Research

The volume of work on industrial effluents undertaken by the Water Pollution Research Laboratory is being extended with the help of a considerable financial contribution from the Federation of British Industries and, as announced in a recent report of the Water Pollution Research Board (Water Pollution Research, 1957, H.M. Stationery Office, London, 1958) a joint committee of the F.B.I. and the Board has been set up to advise on research on problems of pollution in which industry is particularly interested.

"Notes on Water Pollution, No. 1" has just been issued and is the first of a quarterly series which will deal with different aspects of water pollution and its control. The leaflets are intended primarily for industry whose interest in problems of pollution has greatly increased in the past few years, and one of the objects of their publication is to invite the attention of industry to the results of the Laboratory's research, though more detailed accounts of the work will continue to appear in the technical press.

The Port of Felixstowe

Review of Post-War Reconstruction and Development

(Specially Contributed)

FELIXSTOWE DOCK is situated on the eastern side of Harwich Harbour just to seaward of the conflux of the Rivers Orwell and Stour, by which the deep water channel is scoured to a constant depth of some 24-ft., L.W.O.S.T.

The present dock was originally intended only as the tidal basin to a large graving dock extending many yards up the old Walton Creek, in the mouth of which Felixstowe Dock was constructed during the years 1882-1886.

The dock itself is shown in Fig. 1. The width at the entrance is 145-ft. and the width of the basin varies from 300-ft. to 450-ft. The length of the North and South Quays is 480-ft. and 600-ft. respectively. Quay level is 12-ft. O.D. and the level of H.W.O.S.T. is 6-ft. O.D. There is a tidal range (O.S.T.) of 11-ft. 6-in. and the dock is dredged to give a depth of 22-ft. at low water.

Construction of Original Dock

The dock record drawings show that the typical dock wall construction consists of a series of adjoining hollow concrete monoliths surmounted by a gravity retaining wall. Each monolith is about 20-ft. wide, 28-ft. long and 28-ft. high, with concrete walls some 5-ft. thick.

The level at which the monoliths are founded varies, but the majority of them appear to be founded at 36-ft. below Newlyn Datum. From site photographs dating back to the construction of the dock, it is evident that the monoliths were constructed above the final level, and sunk into position by the removal of the ground from the inside of the blocks which were subsequently filled with local ballast.

The ends of the monoliths are formed with recesses which, when filled with concrete, serve as keyways to link adjoining blocks together.

The retaining wall which rests upon the monoliths is a typical gravity wall with a stepped back and battered face. The wall is 11-ft. 3-in. wide at the base and 6-ft. wide at the top and is capped with granite coping stones, the finished top level being 12-ft. above Newlyn Datum.

A temporary wall was constructed at the East or landward end of the dock pending the completion of the proposed graving dock. Only now, 75 years later, is this wall (sloping earth which is retained by a waling and timber piles at the toe of the revetment and covered with concrete slabs) being replaced by a permanent structure.

When the dock was constructed timber piers were built out from the monoliths at the entrance, the North Pier being straight and 150-ft. long, the South Pier having a 15 degree angular curve in its 437-ft. length. A cross-section through the old piers is shown in Fig. 2.

The Felixstowe Dock and Railway Company was incorporated by Act of Parliament in 1875 as the Felixstowe Railway and Pier Company and constructed and operated the railway line from Ipswich to Felixstowe and a pier, since demolished, close southwards of the present dock.

Although this railway undertaking was sold in 1887 when, by a further Act, the Company assumed its present title, the Felixstowe Dock and Railway Company, with its marshalling yards and dock and quayside rail facilities, retains its status as a private railway company, a rarity indeed.

In its early days Felixstowe Dock was used mainly for the import of timber and a saw mill and timber storage sheds were erected.

In 1905 a flour mill was erected on the company's land on the North side of the dock by Messrs. E. Marriage and Son Ltd., of Colchester and the Dock Company erected a large grain storage building immediately westward of the new mill. A malting was erected on the South side of dock which was then and probably remains the largest in the country. This was the commencement of the Felixstowe Dock and Railway Company's service to the farmers of East Anglia, which has increased throughout the years. Drying of crops of all descriptions is now carried out, to the total of many thousands of tons per annum and an official seed-testing station is operated. Although malt is no longer produced, seeds, herbs, pulse and grain — principally malting barley — is dried, screened and handled in large quantities and during the last barley season as a result of the facilities and economy in handling, one third of all the brewing barley exported from England was shipped through Felixstowe Dock.

Having been responsible for some years for coaling naval vessels based at Harwich the advent of oil fuel led, in 1910 to 1913, to the erection of two 2,500-ton capacity and a number of smaller oil storage tanks and the conversion of the north entrance pier to an oil jetty. The service was extended to merchant vessels, and waterboats and tugs for attendance on shipping were operated. Five of the steam rail cranes purchased at this time are still in daily use by the company.

The First and Second World Wars

During the 1914-18 war Felixstowe Dock became a naval base, accommodating the boom defence organisation, torpedo-boat destroyers, minesweepers and auxiliary craft. After the war the boom defence depot was re-established and the Royal Air Force commenced their association with the Dock Company by the establishment of an air sea rescue base, which continues to operate from Felixstowe Dock.

During the 1939-45 war the dock and its buildings were virtually completely requisitioned by the Royal Navy who established there the coastal force base H.M.S. " Beehive " from which light coastal craft attacked enemy convoys on the Dutch coast and helped to protect British and Allied convoys on their perilous passage through " E-boat Alley."

A small quantity of wheat continued to be imported for the use of Marriages Mill but even this ceased temporarily when the grain storage warehouse was destroyed by a falling aircraft.

The company's dredger, hoppers, waterboats and tugs were requiistioned by the Ministry of War Transport and all subsequently became casualties. The loss of the dredger was a severe blow to the company who had previously derived considerable revenue from its operation on behalf of local interests, apart from its value in controlling the silting of the dock.

The end of the war found the Felixstowe Dock and Railway Company in a parlous position. Its trade had disappeared, as had its dredger and plant and, through lack of maintenance dredging, the depth in the dock had decreased from its pre-war 24-ft. L.W.O.S.T. to a maximum of 12-ft. L.W.O.S.T., with patches of only 5½-ft. L.W.O.S.T. in the entrance, allowing access for barges and the smallest coasters only.

Furthermore, the Admiralty had built a wooden jetty out from the East end extending some 200-ft. down the centre of the dock, and the North and South entrance piers had suffered grievously from collision damage and lack of maintenance and repair.

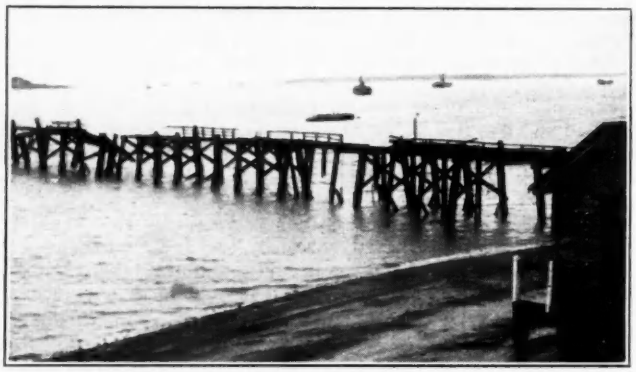
The boom defence organisation remained in residence until the Spring of 1957 and storage and cargo handling facilities were much impaired by the continuing requisition.

The Port of Felixstowe—continued

Post-War Developments

Once again ship salvage companies made the dock their base and a considerable tonnage of salvaged metal was brought in. The Gray and Thomson Salvage Company Limited still operates from Felixstowe Dock.

But otherwise there was little trade and the company was scarcely operating when, in 1951, the control of the company was taken over by Gordon Parker, of Favor Parker and Son, well known Norfolk merchants. Under his vigorous chairmanship a



Wreckage of South Pier after the Storm, Jan. 31—Feb. 1, 1953.

new and active policy was pursued; about 100 acres of land were added to the dock estate; new buildings were erected and were used for the storage of strategic reserves of the Ministry of Food. The oil tanks, de-requisitioned in 1945, were cleaned out and used for the storage of vegetable oils.

Just as the Felixstowe Dock and Railway Company began to get on its feet again there occurred the disastrous floods of February 1953. The dock estate was overwhelmed by flood waters which burst through the flood defences up the River Orwell and swept round to attack the dock from the rear. The east end was shattered, the sea walls fronting the dock were washed away, allowing the waters of Harwich Harbour to encroach on the dock property, the decking was lifted from the entrance piers by the abnormally high tides and the wooden piles of the piers were assaulted by pontoons, barges, craft and debris of all descriptions borne by the flood waters.

The damage, estimated at some £250,000, necessitated major repairs beyond the capacity of the dock company's resources.

The sea walls fronting the dock property were rebuilt in 1957, two new entrance piers were completed early in 1958 and work is now in progress on the re-building of the East end of the dock so as to form a new quay 460-ft. in length. The civil engineering work involved is dealt with section by section.

North Sea Wall

This is a simple steel sheet pile wall, tied back at intervals to anchors. A cross-section is shown in Fig. 3. In plan the wall covers a length of 809-ft. and joins the monolith at the North side of the dock entrance to the existing river board wall, completing the defence on this side of the dock. The lengths of the piles vary from 40-ft. near the monolith to 20-ft. near the embankment, the longer piles being No. 2 and the shorter ones No. 1A Appleby Frodingham sections.

The new wall follows the line of the old defences and, where necessary, the old concrete wall was broken up to allow the sheet piles to be driven. By pitching and driving the piles in pairs and in panels with upper and lower guide walings, the piles were diven without deflection, despite minor obstacles; a No. 6 McKiernan-Terry hammer was used, the piles being handled by a mobile crane.

Exploratory bore holes were made upon the site and a study of these indicated that, in general, the piles would pass through a layer of sand and beach shingle and into the underlying layer of clay. The penetration of the piles varies from 25-ft. for the heavier section pile near the North monolith to 10-ft. for those of lighter section near the river board's wall, and the length of the pile exposed between ground level and coping level varies, therefore, from a maximum of about 15-ft. to a minimum of 10-ft. according to beach level.

To tie the wall back, 2-in. diameter bars are spaced at 15-ft. 9-in. intervals, each being connected to a panel of sheet piles 20-ft. long driven as an anchor behind the wall. The retaining wall is backfilled with local shingle ballast and the tension arising in the tie bars is distributed to the sheet piles by a continuous waling made up of two 12-in. x 4-in. channels back to back. Water collecting behind the wall above high water level is collected in a 4-in. diameter drain and discharged into the sea through a flap valve.

After driving and fixing, all the exposed part of the sheet piles and steelwork were given a second coat of approved bituminous paint and to prevent corrosion of the tie-rods, these were spirally wrapped with "Desmo."

With the level of the new concrete coping standing at 14.5-ft. O.D., some 2-ft. 6-in. above the maximum flood level in 1953, a sound defence is now provided against sea action on the North side of the dock.

South Sea Wall

The South side of the dock has also been protected by constructing a reinforced concrete apron in place of the old sea wall. Reference to the cross-section (Fig. 4) shows the wall to extend over a 20-ft. width. The length is about 560-ft.

The sheet piles at the toe of the wall are mostly Frodingham section and are driven to a depth of 15-ft. into the shingle beach to act as a cut off and to prevent the new apron from being undermined. Lengths of piling left upstanding as cofferdams were burned off at the end of construction. The concrete piles are 10-in. square and 15-ft. long and these hold up the beam which is incorporated into the concrete at the rear of the structure.

A wave wall is cantilevered from the apron and has a top level of 14-ft. above datum.

When the steel and concrete piles were in position, the old wall was broken up and, where necessary, sand and beach shingle were added before the ground was trimmed to the correct level. No

View of Dock Offices showing how closely the sea had approached.

shuttering was required underneath the slab, but before the reinforcement for the main concrete was placed, a 3-in. layer of 1 : 3 : 6 concrete was spread over the sloping surface of the fill. The reinforcing bars at the toe of the wall are bent round hooks in the sheet piles to tie these in to the concrete.

The wall is built in sections, each section is 21-ft. long and is separated from its neighbour by a construction joint formed with a $\frac{3}{8}$-in. strip of Flexcell and sealed with Expandite vertical sealer. Adjoining sections are connected by three 1-in. diameter dowel bars. Any substantial settlement of the fill might lead to crack-

The Port of Felixstowe—*continued*

The Port of Felixstowe—continued

View of the new South Pier.

ing in the slab, and 2-in. diameter holes have, therefore, been placed at intervals in the concrete so that inspection can be made and, if necessary, grout can be pumped into the fill.

A 17-ft. wide ramp has been provided to facilitate the handling of boats and afford access from the beach over the wall to the main road. The surface of the filling behind the parapet wall has been levelled off and covered with tarmac.

North and South Piers

The North and South sea walls described above run into the monoliths, forming part of the original structure on each side of the dock entrance. The two new piers are built out from these monoliths.

Under the pier construction contract it was necessary first to demolish the remains of the existing structures. The longitudinal timbers at deck level were first cut through and individual pile bents isolated. It was found that about 32 ozs. of gelignite was sufficient to cut through each pile in the bent at existing bed level.

The new piers are about as long as the ones they replace, the South Pier being 437-ft. long and the North Pier 150-ft. in length, and each follows closely the line of the old structure. The cross-section of the new piers is shown in Fig. 5 where it will be seen that the 17-ft. wide deck spans across the two longitudinal main beams which connect the rows of single vertical piles at the front or dock entrance channel side and the pairs of raking piles at the rear, respectively.

A pierhead of robust design is constructed at the seaward end of each pier and is joined to the deck by a sliding key so as to minimise the effect of impact on the pierhead upon the main structure.

In all, 87 concrete piles were driven to carry the decking of the two piers. These piles were cast on a site at the east end of the dock, transported to the site of the piers and driven using a pile-frame mounted on two barges. The casting yard was equipped to deal with two sizes of pile 14-in. x 14-in. x 55-ft. long and 16-in. x 16-in. x 65-ft. long, and the bed which was laid out for 12 piles was spanned by a travelling mixer and gantry. A 1 : 1½ : 3 mix was used and proved to give concrete of a very good quality. The main steel reinforcement was 1-in. diameter and this was of mild steel in the 55-ft. piles and Tentor bar in the longer piles. A special lifting beam supported the piles at three points when they were being lifted to stack by a 10-ton derrick with 120-ft. jib. With the use of rapid hardening cement, piles were ready for lifting after three days, and ready for driving after three weeks.

When required in the structure, the piles were lifted into the water and placed in a cradle of steel wires lashed to a number of 40-gallon drums acting as floats. They were then towed out to the barges and lifted by their heads into the leaders of the pile-frame. During lifting, the drums near the toe of the pile were depressed below the water surface and continued to give support to the lower part of the pile.

The 70-ft. high pileframe used for driving the piles was mounted on two 80-ft. long barges rigidly braced together and ballasted to offset the weight of the frame at the bows. These barges were manœuvred into position by steel wire hawsers attached to heavy concrete blocks laid in suitable positions as the job proceeded. A 4-ton hammer was used on the pileframe, the drop being adjusted to suit conditions during driving.

View of East End where new quays are being constructed.

The decking is designed to Ministry of Transport loading standards.

The shuttering for the concrete decking was assembled on a heavy steel framework supported from the piles. One 25-ft. long bay of the deck, was concreted at a time, thus incorporating two vertical piles at the front and two pairs of raking piles at the back of the pier in each length. The concrete was carried from the mixer by a self-propelled skip running on a monorail. At the pier heads, however, where a greater quantity of concrete was required, the skips were replaced by lorries.

The fendering at deck level is continuous along the front edge and the inner and outer timbers are spaced from each other and from the deck in such a way that they must deflect, with proportionate absorption of energy, before substantial thrust on them is transmitted to the deck. Vertical timber fenders suspended at intervals are connected at a lower level by a horizontal waling and raking timbers transmit thrust back to the raking piles at the rear of the deck.

All the timber is 12-in. x 12-in. in cross-section and, to guard against attack by marine borers, was impregnated with "Celcure," a balanced mixture of copper sulphate and dichromates, applied by a vacuum-pressure process. Generally speaking, all steelwork on the fendering is galvanised and painted. A line of Larssen pattern sheet piles driven along the south side of the South Pier for a distance equivalent to the length of the North Pier prevents the accretion in the dock entrance of shingle ballast carried into Harwich Harbour on the flood tide. The piles also serve to counteract the effect of local counter currents induced by the ebb tide and greatly simplify the navigation of the entrance. The scouring effect of the ebb tide results in so little mud being deposited that sheet piling has been found to be unnecessary on the North side of the entrance. The North Pier is once again to be used as an oil jetty. Although bollards are fitted at intervals on the South Pier it is not intended that it be used for loading or

View under the deck of new South Pier.

The Port of Felixstowe—continued

discharging cargo. It is probable that passengers may be embarked and disembarked but its primary use, apart from its importance as an aid to navigation, is as a temporary berth for vessels awaiting a dock berth. Ships which are too long to turn in the dock basin can use the dolphin-type seaward end of the pier to swing, place themselves alongside the pier and can then be warped stern-first into the dock using the 10- and 5-ton electric capstans situated on the north and east sides of the basin.

East Quay

The east end of the dock is to be reconstructed as a sheet piled quay in place of the existing sloping revetment.

The design of the wall is in two parts. For most of its length the sheet piles will be tied back by heavy bars to an anchor beam. In the corners, where space is limited, these bars will be replaced by a horizontal relieving platform with sheet piling at the front and anchored to raking piles at the rear. The 22-ft. depth of water to be provided for shipping at low tide and the tidal variation in water level, are factors which have made necessary the use of the heavy No. 5 Section Frodingham piles.

A 3,500-ton Oil Tanker discharging solvents. The framework of new cattle lairage sheds on left. Wheat Silos and Mills on right.

The reconstruction of this part of the dock is due to be commenced in 1958.

Upon completion of the East end, some £500,000 worth of civil engineering work will have been undertaken since the floods of 1953. The North sea wall was built by Rogers Bros. Ltd., a local contractor, and the South sea wall by direct labour. Both were carried out under the aegis of the East Suffolk and Norfolk River Board. Marples, Ridgway and Partners Limited of London are the contractors for the North and South Piers and for the first part of the work at the east end of the dock, all designed and supervised by the consulting civil engineers to the dock company, Posford, Pavry and Partners of Westminster.

Increased Trading Activity

Whilst all these works have been in progress the dock company has not been idle. A building and maintenance department numbering some thirty to forty tradesmen, artisans and labourers, has been continuously engaged in erecting warehouses and transit sheds, all of which are fully occupied, re-laying the rail lay-out, building new roads and generally improving and modernising the dock and all its facilities. The operations currently in progress include the conversion of the maltings to large grain stores with modernised kilns, erection of workshops and stores 150-ft. by 50-ft., of covered lairage to hold 350 cattle, a barley store 180-ft. by 50-ft., a garage 150-ft. by 50-ft., a canteen, a fertiliser store 240-ft. by 50-ft. and transit sheds with a floor area of 50,000 sq. ft. and a height to the eaves of 20-ft.

A plant for the washing and grading of ballast, dredged from deposits at the entrance to Harwich Harbour, for use in the many reconstructtion projects in hand, and for sale commercially has been erected at the seaward end of the North Quay.

During 1957 the single rail track on the South Quay was replaced by a double track mounted on concrete beams and the surface of the quay concreted. Similar work is in progress on the North Quay where three parallel tracks are being laid.

A new tank farm, specially developed for the storage of low flash point chemicals and solvents, at present consists of six tanks with an aggregate capacity of 6,500 tons. All existing tanks are in use and more tanks are in process of erection. The dock company arranges the delivery of these chemicals in bulk and barrel all over the country and operates a drumming installation.

Four new diesel and diesel-electric cranes have been obtained in recent months, lifting capacities being up to 7 tons and jib lengths up to 50-ft. The dock company also arranges for the use of the 50-ton crane at the Royal Air Force Station adjacent to the dock.

All quays, wharves, warehouses and transit sheds are served by road and rail and full use is made of mechanical handling equipment.

There has been a marked increase in the trade of Felixstowe Dock during the last three years. In 1957 some 20,000 live cattle were exported to the Continent. General cargoes to and from Germany are handled regularly and a regular service to and from Holland may well be inaugurated in the very near future. The company now import timber continuously. All the original tanks are being used for the importation and distribution of hydrocarbon oils. Other commodities regularly loaded and discharged include ammunition and explosives, fertilisers in bulk and bag, seeds, malt, strawboard, steel, various agricultural and chemical products, frozen meat, beer etc.

The General Manager is Lt.-Commander I. C. Trelawny, D.S.C. and the Dockmaster is Captain C. E. Morgan.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Littoral Movement of Sand at the Port of Abidjan

The Supplementary Note in your June 1958 issue concerning the movement of sand on the beaches near the new Vridi Canal at Abidjan, raises a point which requires some clarification. It is suggested that the west to east littoral drift of sand, estimated at about one million tons every year, is caused by inshore currents related to the Guinea Current, and it is stated that it is surprising that a new sand beach is forming to the west of the West Breakwater, which was built to protect the entrance to the canal. The article goes on to say that the explanation may lie in the local topography of the beach, which forms a promontory and induces a significant eddying effect.

In fact the littoral drift on this coast is dominated by currents caused by wave action and as a result it was possible, by means of the model investigation carried out in Delft in 1934, to predict the effect on the neighbouring coastline of the construction of the Vridi Canal, and to choose the best site for this canal. Just offshore near the mouth of the canal there is a deep depression in the sea bed known as the "Bottomless Pit." This has a perturbing influence on the direction of the waves and, combined with the slight change in the alignment of the coast near Port Bouet, produces a variation in the quantity of littoral drift. In 1935 it was estimated that the coast at Port Bouet, opposite the Bottomless Pit, was advancing continuously seawards at a rate of 3-ft. per year*. The accretion occurred because the sections of coast on either side of Port Bouet were stable while about one million tons of sand travelled from the west towards Port Bouet each year and only half this amount was moved along the coast again eastwards of the Port; this was a direct result of the wave conditions in the area.

The accumulation of sand to the west of the West Breakwater of the Vridi Canal is a natural result of the littoral drift from west to east caused by the waves, and it is therefore unnecessary to explain the littoral drift in terms of a "significant eddying effect."

Hydraulics Research Station, Yours faithfully,
D.S.I.R., Wallingford, Berks. W. J. REID.
3rd July, 1958.

*M. Blosset, Report No. 70, International Navigation Congress, Brussels, 1935.

I.C.H.C.A. Conference at San Sebastian

Meeting Organised by Spanish National Committee

The four main subjects discussed during the 1958 Technical Conference of the International Cargo Handling Co-ordination Association held at San Sebastian last May, were "Loading and discharging in open roadsteads," "The ideal port for handling 1,000,000 tons of general cargo per annum," "The training of dock workers" and "The training of port supervisory staff." Representation at the conference was wide for, besides the large number of European delegates, there were representatives from Chili, Israel, Japan, Mexico, Thailand, Turkey and Venezuela.

Loading and Discharging in Open Roadsteads

This paper was read by Commander A. D. Charvet (French National Committee of I.C.H.C.A.) who said that many ports have insufficient traffic to justify even a modest amount of port equipment and into this category fell a number of the ports situated in Madagascar, in Central and South America, and on the eastern and western coasts of Africa.

"Open roadstead working," said Commander Charvet," calls forth many complaints from shipowners, receivers and shippers alike. Certain shipping companies, indeed, hesitate to call regularly at such ports since they know the available facilities leave much to be desired. The shipowners complain of the means of access and also of the facilities that are offered them.

"Although most roadsteads are relatively easy of access, nevertheless it should be mentioned that some places in Nigeria and Chile are notorious for the fact that navigational channels are insufficiently indicated. These are only isolated cases, nevertheless such 'inconveniences' constitute a real danger to navigation and, during 1956, about 40 cases of stranding could be attributed to an insufficient number of marking buoys. Moreover, the convergence of too large a number of ships on the same roadstead at the same time causes delays which are often considerable. This is particularly the case in certain places in Madagascar and on the West Coast of Africa."

Various steps have been taken to remedy this situation but "the biggest headache for owners whose vessels call at roadsteads is caused by the slowness of cargo operations. This situation is particularly critical on the East and West coasts of Africa and on the coast of Chile, where numerous loading points are merely precarious anchorages, often obstructed by a bar. The slowness of cargo operations means that to deal with a certain volume of traffic, a disproportionate number of vessels is required, and this of course neutralises the advantages of greater sea speed. The local authorities, spurred on by the various shipowners' conferences and faced by unavoidable surcharges on freight, are trying to find remedies for the situation.

"The causes are manifold, but are principally the extreme age or insufficient number of lighters, boats, tugs and other craft used to transport the cargo between ship and shore, the general insufficiency of methods of horizontal transport, the unskilled labour and local difficulties.

"On the East Coast of Africa the rate of discharge barely exceeds 25 to 26 tons per day, or 30 to 32 on the West coast and on Chilean roadsteads. These rates refer to liners only; when it comes to tramps, it is not unusual to find a vessel taking a month to load 2,500 to 3,000 tons of general cargo.

"It is useless to boast that ships' gear is vastly superior to the mechanical handling equipment available at roadsteads; this is precisely the point on which improvements are most urgently needed. One solution to this problem, at least for the immediate future, would be to use a small container; but up to the present nothing seems to have been done to ensure the necessary conditions for its utilisation.

"Data on equipment available on shore for handling goods show that marked differences exist at different ports; on the East Coast of Africa, handling is practically exclusively manual. On the other hand, mechanisation is highly developed on the West Coast of Africa, where stevedores use a large number of mechanical devices, the most widely used being the fork lift.

"Finally, rightly or wrongly, the labour force used at roadsteads suffers very greatly in any comparison with a major port. These dockers are, generally speaking, very amiable and willing, but not easily adaptable to modern techniques and all too often lack initiative.

"From a study of various opinions on this important question, one gains the impression that a higher degree of training would certainly improve the dockers' output; but the principal object to be aimed at is really the introduction of a nucleus of technically skilled personnel, who should have the necessary moral qualities to enable them to direct the work.

"To receivers and shippers it is principally the cost and the safety of handling operations that are of interest. The position in roadsteads as regards losses and damage is undeniably bad. Crossing the bars on the West Coast of Africa results all too often in damage by wetting and much cargo is dropped into the sea. Incidents of this kind can never be completely eliminated but they would be greatly reduced if the lightermen had better equipment, particularly lighters and tenders that are more solidly built, better protected and better equipped.

"It is an undeniable fact that this problem is all too often passed over in silence, either because the ships forget to mention it or because the shore services do all they can to conceal the truth."

The author then went on to examine the problems posed by open roadstead working of certain specialised ships like tankers and banana vessels and in conclusion remarked that "heavy swell and choppy seas can greatly delay a ship's stay; and indeed at certain times of the year it is often quite impossible to carry out any operations for several days. This is one of those unpredictable factors which greatly increases the problems of using roadsteads.

"There is no doubt whatever that the efforts of shipowners the world over to equip their ships with more numerous and powerful handling appliances is unfortunately largely nullified by the lack of gear at the disposal of the public or private bodies which control the type of port we have been examining.

"This state of affairs is largely the inevitable consequence of the speed and extent of the economic development of the territories concerned. Nevertheless it is equally true that certain improvements could be immediately effected, particularly in regard to buoys. Modernisation of existing equipment—which is being undertaken in a large number of ports, ought to enable the needs of the immediate future to be met, as the present situation is one that ought not to be allowed to continue. It might also be possible to speed up handling operations by using fairly small containers, while the construction of flimsy wharves would avoid the risk of lighters running aground.

"Before long the increasing volume of traffic and the use of larger ships for commercial purposes will make adequate gear an absolute necessity; and those ports which, in the future, will be served by ships of large tonnage will have to equip themselves very rapidly if they wish to survive.

"Finally, the difficult problem of labour which to a great extent governs the speed of handling operations, cannot be passed over in silence. The various aspects of this problem are too well known to require repetition here; but it would appear that no tangible improvements can be achieved without a greater degree of training for the workers."

The Ideal Port for Handling One Million Tons of General Cargo Per Annum

This subject was inspired by the papers read on "The Ideal Port" at the 1954 I.C.H.C.A. Conference. The author, Don José María Hidalgo de Quintana (civil engineering director of the Port of Pasajes) listed the different factors affecting the work of a port dealing with some 1,500 to 2,000 general cargo ships a year (say a million tons of cargo) and, after advancing views on general administration, stated in conclusion:

"1. The ideal port for a varied traffic of one million tons per annum is that resembling most nearly the general conclusions adopted at the above-mentioned Conference in 1954, particularly with the second and third conclusions, which require:

A certain degree of autonomy for the Port Authority.

That the Port Authority may have sufficient power to ensure an efficient co-ordination of the various activities of the port.

I.C.H.C.A Conference at San Sebastian—conitnued

That services given by the Port Authority are based on sound commercial principles.

That times in which the administrative services of the port (Customs, Police, etc.) are given, do not cause any delay to the port operations.

That ships forward to the port the particulars of their stowage arrangements and any further information to facilitate operations in the port, in sufficient time prior to their arrival.

"2. That the best technical features for works and installations must be studied individually, bearing in mind the decisive local factors peculiar to the physical conditions of the port, to the nature of its traffic and to the uses and customs of the port.

"3. Where the Port Administration does not receive assistance or subsidies from the State, Province or Town bodies, it will have to do its best to increase income as much as is necessary to finance improvements and enlargements made necessary by the increased traffic."

The Training of Dock Workers

This is a subject which will be of vital interest to port labour employers for many years to come and most schemes—and there are too few of them—take into account that, as mechanical handling methods are evolved, the docker is becoming a skilled worker. At San Sebastian, Mr. A. Peters, Jr. (director of the Dockers' Training School at Rotterdam) was listened to with keen attention. In outlining the development of vocational training of adults in the port of Rotterdam, Mr. Peters said:

"For a long time before the second World War, many people strongly felt the desire and the necessity—which was also due to the new Act concerning the loading and discharging of sea-going vessels—to start a special training for particular classes of workers in the port. In 1949 the 'Shipping Federation South' (Shipping Federation of Employers in the Port of Rotterdam) started with a Department of Vocational Training.

"This consists of four phases:

"1. **Basic training** of dockworkers (for work in the hold and alongside on the quays and in the barges), warehousemen, trimmers, etc.

"2. **Training of specialists** such as winchdrivers, signal men, tallymen and forktruck drivers.

"3. **General training of supervisory personnel,** such as assistant foremen, foremen, etc.

"4. **Training of specialist foremen,** such as foremen in general cargo handling, in warehouses, foremen for elevator work, foremen for bulk-cargo handling.

"About 4,000 men took part in a training course."

Other courses for adults (non-vocational training)

The Vocational Training Department also organises special courses as: English language for beginners and advanced pupils; general education (Dutch, arithmetic, knowledge of our country); safety in industry; First Aid etc.

"Though there was every reason to be satisfied with the results so far, we were not fully satisfied. We found that the training of future foremen, who after basic training and selection were given a specialist course, was incomplete and in a way we were not surprised.

(a) In the first place the training scheme in its present form was limited too much to mere technique. The building up of team-spirit, of teamwork, the grasping of the special atmosphere and climate typical for dock work, all of these factors form a dockworker's mentality.

(b) Another conclusion we reached about training, was that the average is too old.

(c) A third factor is that improvement of working methods is necessary. It all depends on how one sees the future of the port. There is a real danger that we shall be placed before grave difficulties if the training of dock labour does not cope in time with technical developments.

(d) Many industries have the same experience as the dock industry; without some general education every experiment in technical training is bound to be a failure.

(e) Several of the above-mentioned problems can be solved by starting the training of much younger boys.

"In setting up a dockers' training school for boys," Mr. Peters went on, "the following two factors were considered:

(i) the need of well-trained reliable workers, able to bear responsibility;

(ii) the young people's need of education and training to become skilled workers and better persons.

"The school aims at:

"1. **Pedagogical.** Mental and moral education, character-building.

"2. **Technical.** Imparting to the pupils the 'tricks of the trade' with regard to loading and discharging of vessels, warehouse, despatch and checking work, as well as to the handling of cereals.

"3. **Social.** Giving a perspective for the future, promoting team-spirit, making the pupil enjoy his work and giving him an idea of a useful way to spend his free time."

In conclusion, the author gave the following summary of the education scheme:

"**Preparatory class** (13 to 14 years old)—In order to bridge the gap from Primary School to the Dockers' Training School, the Preparatory class has been formed.

"**Dockers' Training School** (14 to 16 years old).

"**Apprenticeship** (16 to 18 years old).

"**Dock work in practice, military service** (till age 22).

"**Final classes** (continued specialised education)—The pupil can be trained at the Department for Vocational Training for Adults for:

(a) **Technical work** (mechanical and electro-technical appliances). Functions: winchdriver, forktruck driver, bulldozer driver, signal-man, store-worker, crane-driver, etc.

(b) **Administrative and checking work.** Functions: weigher, measurer, gauger, checker, administration (of wages), tallyman, foreman checker, etc.

(c) **More responsible positions.** Assistant foreman, foreman, etc. in general-cargo handling, in warehouse, in bulk-cargo handling, elevator work."

Some Thoughts on the Training of Port Supervisory Staff

In his paper Mr. R. B. Oram (port consultant I.C.H.C.A.) began by pointing out the born trainers of other men were rare. It was no longer good enough to leave the training of a supervisor to the haphazard attention of his immediate senior. There were three types of officials directly responsible for the disposition of tonnage passing through the ports, and, said Mr. Oram, "before dealing with the problem of training supervisory staff, we should first have the distinction between the three grades quite clear. The activities in which each is engaged obviously vary to an extent that demands different treatment. In attempting to make the distinction, it must be understood that the grades are generic, that the system at no particular port is being described and that many ports may be adequately run by supervisory grades that do not fall within the categories treated.

(a) There is, firstly, the large and important body of foremen, foremen quay gangers, foreman shipworkers and a host of like sub-divisions. They are directly in touch with labour and are closely responsible for the extent and character of the work done.

(b) Secondly, there is the grade above these—the traffic officers. Whilst the foremen class may be likened to the Non-Commissioned and the Warrant Officers who are regarded as the backbone of most armies, the traffic officers and their like exercise similar functions to those of the Regimental officers of a unit, save that their work is seldom as closely defined. A traffic officer may be thought of as the official who is directly responsible to the port employer for the discharge or loading of a ship, or for the successful day by day work of dock sheds or warehouses.

(c) Thirdly, there is the executive grade, and this may be taken as the relatively small section of managers and their personal staff.

I.C.H.C.A Conference at San Sebastian—continued

" It is now necessary to consider what practical forms of training are open and could be made available in the circumstances of their employment, to each of the three grades described. In the case of the foremen, it is first necessary to detach them from their daily routine, for the excellent performance of which they are, as a class, well known. The problem is to induce them to lift their eyes from the work which normally absorbs them and to fix their gaze on that of their own port. This may, and should, lead to a growth of interest in the wider aspects of the industry. It is not an unpractical suggestion to make that they should be taken from their duties for an afternoon a week, and given instruction in cargo handling. Theoretical instruction could be followed by practical demonstration and visits to departments where the processes that have been described could be seen in operation.

" I.C.H.C.A.'s Central Office has produced a draft syllabus for twelve lectures on cargo handling. These are mentioned here because they are regarded as being the basis for a course of training on the lines suggested above. A brief summary of the contents of this syllabus is given:

(i) The importance of a maritime port, the physical conditions postulated and the elements of the carriage of goods by ship.
(ii) The types of ports, dictated by physical and also economic requirements. The division into docks and anchorages, and the mechanism of allocating berths and of berthing ships.
(iii) Other factors of importance — road and rail access, and facilities for the free movement of craft. The more general methods employed in carrying cargo and the types into which cargo falls; bulk, homogeneous, specialised and general.
(iv) The purposes for which cargo is landed, sorting, sampling, customs clearance, market conditions, damage problems and salvage. The machinery of ship discharge, the basic documentation, the gang organisation. Collateral arrangements on the quay, including rail and road deliveries.
(v) Handling cargo for loading. Receiving, shedding, and the stowage of the ship. Documentation, labour organisation, shut outs etc.
(vi) The human side of the work, labour and its problems. Day by day working conditions, piecework, overtime, special payments etc.
(vii) Handling methods, overside and ashore; special equipment now available and its effect on gang manning. The principles that govern the selection of mechanical equipment. Static equipment, such as weighbridges, capstans, turntables etc. Benefits of mechanical handling of cargo.
(viii) The impact of the new mechanical handling on the design and construction of dock premises. How existing physical conditions are rarely suitable for exploiting the potentialities of the new equipment. The requirements that are necessary for this.
(ix) Bulk cargoes. Methods of unloading. Homogeneous cargoes. Methods of unloading. How far can these processes be further mechanised?
(x) A study in detail of the handling of certain cargoes: hardwood, softwood, wines and spirits, sugar, wool, meat, tobacco etc. How work study is initiated ; looking for bottlenecks, fixing new rates.
(xi) Organisations whose activities affect the rate at which cargo can be handled. Customs, safety and health organisations, the unions, both labour and clerical. The considerations that have to be given to cargo handling in the management of a dock estate.
(xii) A survey of the recent radical changes in ship design, port installations and handling equipment, and an attempt to probe the future lines of development of these. A note on the different systems of managing ports.

" It will be clear that staff who attend a course of lectures on the above lines and are given also the opportunity to see the practical work as well, will have eventually a more comprehensive idea of the problems on their level; it would be an advantage if those lectures which deal with specialist subjects were given by the specialists concerned, particularly that on the berthing of ships by the dockmaster.

" The traffic officers, whilst they would undoubtedly supplement their existing knowledge by the course of lectures—for no man is likely to master all the branches of cargo handling entirely by personal experience—require instruction in the wider field of port practices. They need to know what is going on at other ports. The best, and in the long run the cheapest way to acquire this knowledge is by an interchange system between ports. Their training should have the emphasis laid on the principles that govern development, particularly with mechanical equipment and the construction of dock premises.

" The technical press, not only of their own country, can be used to provide a wealth of interest. There should be a free circulation of these magazines and journals. So that their full value may be extracted, senior officers should be encouraged to hold regular meetings say, at quarterly intervals, with their junior officers.

" Very little space has been left for higher executives, who are relatively few in number. By the time they have reached the apex of the pyramid, they will most certainly have formed definite opinions on the personal opportunities for improving knowledge that their position affords. These can be suggested in a tentative way only.

" Firstly, there is travel, on a wider scale of course than that suggested for traffic officers. The interchange of experience and the discussion on mutual problems between the executives of two ports will obviously take a form different from the more practical talks between more junior officers.

" Secondly, there is a wider technical press open to executives. It is not suggested that they should delve into this themselves; it should be scrutinised by an officer competent to detect, often from sources that appear unlikely, the trend that commercial expansion will take, and the ways in which his own port may be affected.

" In this connection, an idea is put forward which may provoke discussion. There are those executives who hold that a dock undertaking is not justified in spending money installing equipment so as to offer facilities for an industry that is hesitating about expansion. Others consider that it is their duty to provide the facilities, in the belief that the traffic will flow to these. In the case of a port where the latter view prevails, it is suggested that a small committee of senior officers should be charged with the duty of searching out the signs of industrial change, of detecting symptoms of alterations in established processes, and then of formulating policies that will cope with the changes if and when they come."

The final session of the conference was devoted to a review of administrative factors (" red tape ") which delay the movement of cargo on the quay. Various views and suggestions were put forward, including that shed accommodation should be booked in advance, shipping documents should be sufficiently instructive and that shipping notes, bills of lading, masters' receipts and other forms should be standardised. In summing up, Mr. Rene Courau (President of I.C.H.C.A.) said that the problem was a delicate one and I.C.H.C.A. was not the first organisation to address itself to it. I.C.H.C.A., however, was a private body and should remain so. It therefore should continue to study the problem without committing itself.

V.H.F. Radio for Port of Karachi

A V.H.F. radio system has been installed by the Karachi Port Trust to improve the efficiency of the port operation and control the movements of tugs and pilot launches in the harbour and its approaches. Marconi 10 watt F.M. transmitter/receivers arranged for duplex operation have been used throughout. The scheme provides for fixed stations in the offices of the harbour master, dock master and the mechanical engineer and five mobiles fitted in the three tugs and two pilot launches under the control of the harbour authorities. Power supply for the fixed stations is provided by batteries so that, in the event of a failure of the public electricity supply, the system will continue to function. In operation, this system will prevent serious wastage of ships' time caused by delays in locating and directing tugs and launches.

The Ships' Gear and Quay Cranes Controversy

The Loading and Unloading of General Cargo

By E. S. TOOTH.

THIS controversy is as old as the quay crane, which first appeared as a hand machine so long ago that its hydraulically-driven successor, though a product of the first half of the nineteenth century, is comparatively modern. During the last fifty years, however, both quay cranes and ship's gear have passed through several stages of development, the most recent having been stimulated by post-war peak-trading conditions.

Modern Quay Cranes

Before discussing the relative merits of these two methods of handling goods to and from general cargo vessels, it will be useful to examine what they really are and why the divergences of opinion and practice have arisen. In whatever way modern quay cranes are constructed—whether for performance or to suit the geography of the berth—they have certain common characteristics. Whether they have straight jibs or "goosenecks," four legs or three, or span the whole quay (with, perhaps, two legs on an upper part of the transit premises) or only part of it, fundamentally they are similar machines. With few exceptions they are electrically driven, speedy on all motions—hoisting, lowering, slewing, luffing, self-propelling and level-luffing. On modern ship loading and discharging berths in many world ports, one is likely to find batteries of such cranes capable of hoisting 3 or 5 tons at a radius of 80-ft. or more and at a speed of some 250-ft. per minute.

Modern Ships' Gear

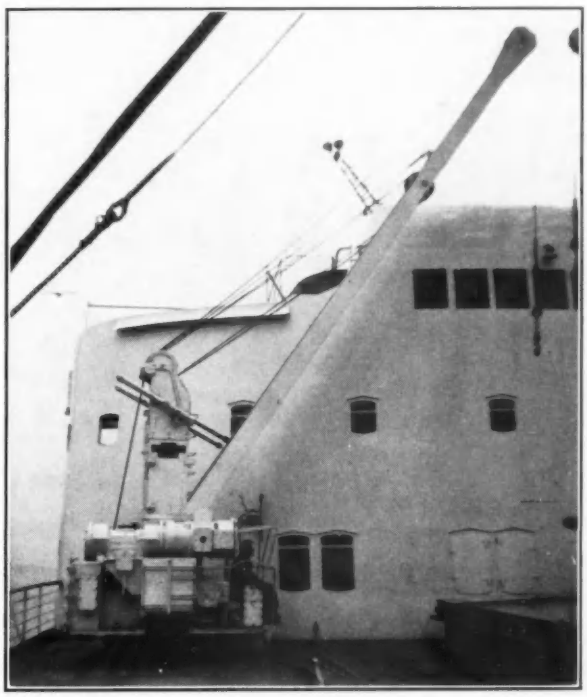
Ships' gear for handling piece goods (bulk and special cargoes are not being discussed) varies over a wider range. It includes the conventional derricks and winches and also deck cranes. Derricks for general purposes are also usually of 3 tons or 5 tons capacity and will reach, perhaps, 10-ft. to 20-ft. over the ship's side. To increase outreach, the derrick heel is often moved away from the centre-line of the ship and on some of the most recently constructed vessels it is actually outside the line of the hatch coaming. Winch power is rapidly changing from steam to electricity, due largely to the change over to Diesel propulsion. Very often the main holds of a vessel are equipped with heavy-duty derricks of 10, 25, 50 or even 100 tons capacity and it will be seen later why these are installed even on general cargo ships. At the present time, deck cranes, which are usually electrically driven (although sometimes powered by internal combustion engine) are more common on short-sea than on ocean-going ships. There is no doubt, however, that they are returning to favour.

Capacities, outreach and design vary widely. Some ships are equipped with one fixed crane at each hold, others have two. In rare instances there are four, one at each corner of the hatchway. Where there are two cranes, they are often staggered so that (a) work can proceed simultaneously on both sides of the ship and (b) when the cranes are appropriately placed, four can plumb one hold—at the expense of an adjacent hold, of course. With cranes, too, of course, siting on the centre line of the ship seriously curtails outreach—which is another reason for staggering (Fig. 1).

Some vessels are equipped with cranes which travel on tracks, which run either athwart or fore and aft the deck. In the latter case, the crane usually spans the hold. Capacities and radii vary, too. Most ships' cranes are now level-luffing and have capacities varying between two and five tons (or similar weights to the nearest 1,000 kilos). A common capacity on ships built on the continent of Europe is 3,000 kilos. A heavy-duty deck crane (which when installed, is usually at the main hold) will have a capacity of 20 tons or more (Fig. 2). Working radii and outreach over the ship's side are often greater than those of ships' derricks. Fourteen metres is a common radius. Hoisting speeds of winches may be 100-ft./130-ft. per minute; of ship's cranes 100-ft./150-ft. per minute.

Some ships are constructed with both derricks and cranes. A vessel engaged in trade between Great Britain and Scandinavia, for example, has one derrick forward of No. 1 hatch, one 3-ton crane between Nos. 1 and 2 hatches and one 3-ton crane, abaft of No. 2. The cranes are sited on the centre line of the ship and have 46-ft. level luffing jibs. As the ship has a beam of 35-ft., the maximum outreach from the ship's side is about 23-ft.

Another vessel (built at Nurnberg in 1957) has a deck crane of 3 tons or 5 tons capacity on each side of each of her five holds and also at least two derricks at each of three of those holds (Figs. 4 and 5).



[Photo Clarke, Chapman & Co. Ltd.]

Fig. 1. Deck crane placed near ship's rail to give good outreach.

The Two Systems

Before attempting to ascertain the basis of this controversy, it will be worth while looking into one other matter—the kind of cargoes the purchases mentioned have to handle. Britain's maritime traffic is taken as an example. Her "general" imports range from refrigerated meat, fresh fruit, dried fruit, hardwood logs, cut lumber, reels of linerboard, bales of plywood, crates of veneers, dairy produce, wines, wool, rubber, canned goods and sugar, to spices, gums, essential oils, shells, perfumes, last blocks, ivory and drugs; her exports from asbestos cement sheets to 80-ton boilers, from spirits, stockings, galvanised hardware, dyes, paints, razor blades, earthenware pipes, herrings, cereals and chemicals, to machinery, girders, drums of cable, railway engines and coaches, motor cars and omnibuses.

This conflict of two systems is not as straightforward in character as it seems at first sight. Ostensibly it has been about whether it is satisfactory for loading and discharging agents to rely only on ships' gear for handling miscellaneous freights into and out of general cargo vessels. In point of fact, however, the choice between ships' gear and shore cranes does not always

Ships' Gear versus Quay Cranes—continued

exist, one reason being that some berths have had to be constructed at places where there is such a big tidal range that the employment of ships' gear is difficult, if not impossible, at certain states of the tide.

Another complicating factor is that in many major ports, ships' gear is used in conjunction with shore winches, to the complete exclusion of shore cranes. This practice exists mainly in the United States but it is such an important one that discussion usually leaves simple issues and revolves round the relative merits of the American system of finger piers and housefalls and the European system of marginal wharves and shore cranes.

There is no doubt that comparisons between systems of working are made difficult by the diversity of traditional handling methods, even in ports in the same country (which in the U.S. may be 3,000 miles apart). The problem becomes really complex when comparisons are made between ports of different countries. Most U.S. authorities will support the American method of using ships' gear with the aid of "burtoning" masts. Normally the range of tide is sufficiently small on both the Atlantic and the Pacific coasts to obviate the need of building enclosed docks. The practice was therefore to construct piers or wharves out into the bay, harbour or river and ships approached them and also worked at them at all states of the tide. In the older-established east coast ports, the piers generally have a narrow quay margin but on the west coast, designs are more modern.

[Photo Clyde Crane & Engineering Co. Ltd.]

Fig. 2. 20-tons electric dock crane.

Quays and transit sheds are wide; road and rail access good. Yet practically none of these ports, Atlantic coast or Pacific, is equipped with shore cranes, and at most, they have "housefall" appliances to facilitate loading and unloading operations. These are usually strong metal masts erected on the quay or against the face of the shed (sometimes multi-storied) and connected near their peaks by a strong girder. To that girder a pulley block can be attached opposite each hatch with a wire runner (a "housefall") operated by a winch on the quay (sometimes in the shed) working in conjunction with one of the runners and winches on the ship (Fig. 3). Thus sets of cargo are moved between hold and any storey of the shed by the joint operation of the pier winch and one of the ship's winches. This method is encountered elsewhere in United States' sphere of influence—in the Philippine Islands, for example.

In many instances, the primary reason why finger piers were built was to consume as little of the water front as possible. Many of them would not support batteries of modern shore cranes without extensive and costly alteration; but that is not important to the local authorities because housefall and burtoning, it is said, were developed to do away with the need for expensive cranes. Most American port operators argue—and with some justification — that the purpose of ships' derricks and ships' cranes is to load and discharge the ship and they should do the job for which they were provided. Finer points are watched in the endeavour to make the ships' gear method efficient. At New Orleans, for example, a shed and wharf have been built on a higher level from the river than is usual, with the result that for a large proportion of the loading and unloading times the ships' derricks can work with the minimum of lifting.

Another argument put forward by advocates of the U.S. system is that a crane is an economical machine at a wharf with a high utilisation but certainly cannot compare economically with a housefall at a pier that has a ship alongside only 25% of its time. Whilst most major ports of the world are so busy, this argument does not appear to apply.

Another authority has suggested that a different policy might be adopted if facilities in a U.S. port were controlled by one body. In the U.S. it is rare, in fact, for the berths at a major port to be owned by one authority, even the port authority, as the following table shows:—

Ownership of Deep-Draft Sea Berths

Port		Private	Railroad	Municipal	State or Port Authority	Federal
Boston	...	77%	8%	5%	8%	27%
New York	...	30%	10%	44%	10%	6%
Philadelphia	...	48%	30%	15%	—	5%
Baltimore	...	54%	30%	12%	1%	3%
New Orleans	...	25%	10%	—	56%	9%
Houston	...	70%	4%	—	22%	4%
Los Angeles	...	24%	—	68%	—	8%
San Francisco	...	9%	3%	—	71%	17%

When this question of ships' gear versus quay cranes has been studied in America, investigations there have naturally tended to be academic—just as, in fact, comparisons with the housefall method must be in Europe. Nevertheless, even in Europe, where good opportunity exists to make comparisons between actual performances of cranes and derricks (on marginal river or dock berths without housefalls, of course), there has not been unanimity of opinion. This may be because there is a clash between operating and economic considerations — a doubtful difference, which will be examined later.

A recent study made in a Southern European port is illustrative of the "pro-ships' gear" point of view. The conclusion was that "as regards most of the goods designated as general cargo packed in bales, boxes, barrels, bundles, etc., the use of cranes does not increase the speed of loading or unloading over that reached by ships' derricks. Indeed, it is useless to have a powerful and quick device such as a crane, if the operations of fastening or unfastening the slings, stowing or breaking down, as well as the lightness of the weight, do not allow cranes to be used to their full capacity. This means that the modern crane, powerful, quick and costly when used for the handling of general cargo, represents a useless waste . . . for the same results can be obtained with the ships' derricks on which the initial cost and maintenance expenses are much lower."

Most port operators in Europe would agree with only one point in this conclusion, viz. that the quay crane is a quicker handling device than ships' gear. One European authority recently stated, in fact, that outputs of general cargo by crane gangs are sometimes 50% to 70% greater than those of gangs using ships' gear. However, referring back to the conclusion quoted, if the purchases were not being fully employed, steps would be taken in most ports, by manning adjustments, for example, or by the provision of mechanical appliances, to speed the work in the hold, on the quay or in the barge so that a heavier duty fell on the primary purchase. Indeed, it is unlikely that there would be this controversy, if speeds of loading and discharging were usually controlled by some other factor than the efficiency of the purchase serving the hold.

Advantages of Quay Cranes

It will now be useful to examine the relative merits and demerits of quay cranes and ships' gear, bearing always in mind that the miscellaneous goods which make up general cargoes have to be put into and taken out of vessels of various designs, the older ones having alleyways, tanks, lockers, propeller-shaft tunnels and even stanchions. At most ports, the bulk of goods,

Ships' Gear versus Quay Cranes—continued

whether import or export, are shedded, the balance being discharged direct into or loaded direct from road, rail or water conveyance. Governing all these operations is the need for safe and speedy working.

Some advocates of ships' gear will state that one cannot expect the crane, an all-purpose machine, to do every job as well as gear which is constructed particularly to serve its own ship. Quay cranes can, however, pick up from and place in any part of the square of the hatch, any part of a road or rail vehicle and both ends of a barge. This is particularly useful when heavy or bulky cargo, such as logs of hardwood, reels of linerboard and motor cars, is being handled. Quay cranes can also plumb any spot in a large area of the quay and reach to upper floors of adjacent sheds or warehouses. The value of quay cranes at berths where there is a big tidal range is obvious, so is the value of their greater hoisting speed.

Another operating advantage is the ability to work intermittently to shore and to barge without delays comparable with those caused by rerigging derricks. This can be done either by reaching across a ship of narrow beam or by working to a barge placed between ship and quay. It is advantageous, too, that the driver (one man, instead of often two men driving winches) usually knows his machine and, when manipulating his load, has no derrick guys to avoid and can more easily clear deck obstructions. (The installing on ships of bipod masts, by the way, has given more freedom of action not only to quay cranes but to ships' derricks). Further, the crane can be used to supplement ships' gear. It is the turn-round of the vessel which is usually of paramount importance—not the outputs of individual gangs. Two gangs in a hold, one using a shore crane and the other a ship's purchase, can often discharge cargo at, say, one and three quarters times the speed of one gang.

It has already been stated that most modern quays in "crane ports" are equipped with cranes of 3-tons and 5-tons capacity. More heavy packages are now being transported across the seas and there is a growing demand in many quarters for each general cargo berth to have a crane capable of handling heavy lifts and also containers, which may weigh up to, say, seven tons. When equipping the berth with cranes, therefore, it is often the practice to place two 5-tons cranes together so that, by using a common runner, they can lift loads up to, say, 8½ to 9 tons. This often avoids the delay and expense of moving a ship to another berth or the employment of a floating crane.

A final but pertinent comment under this heading is that some vessels, which it is known will ply between crane ports, are actually being built without ship's gear of any kind.

Advantages of Ships' Gear

Ships' derricks and ships' cranes in their turn have certain operating advantages over quay cranes. They can be rigged for work so that loading or discharging operations can commence immediately the ship is alongside the berth. When using quay cranes, time has to be spent placing them in positions relative to the holds they are to serve. Ships' derricks, too, can always work on either side of the hold.

As far as speed of working is concerned, in certain circumstances, particularly when large parcels of bagged goods are being handled, an experienced gang can discharge cargo from hold to barge more quickly by union purchase (married fall) or even swinging derrick than by quay crane. One reason for this is that the distance the set has to travel is usually shorter when ships' gear is employed; another is that such goods can often be drawn under plumb quickly and without suffering damage. Such cargoes and stowages, however, are the exception rather than the rule.

Although ships' cranes have much smaller working radii than quay cranes, they can usually plumb most parts of the hatchway and are thus often equally efficient as far as work on the ship itself is concerned. Often, too, the driver's position enables him to see into the hold, a factor in favour of speed and safety. It is at the other end of the operation—the quay or the barge—where the ship's crane loses in comparison with the quay crane, simply, again, because of the limited area of its plumb.

Another point made by advocates of ships' gear is that movement of goods on the quay (and particularly on a narrow quay) is restricted by the presence of shore cranes, even if they rest partly on adjacent premises. This is a valid criticism, which assumes more importance when powered appliances are used for handling.

In favour of quay cranes, it was stated that some vessels have no equipment for loading and discharging. In favour of ship's gear is the obvious fact that ships may have to work at buoys berths (or suffer long delays) and thus be entirely dependent upon their own equipment.

The Economic Factor

The more one examines this question, the greater becomes the temptation to believe that arguments in favour of quay cranes are mainly operating ones and those in support of ships' gear mainly economic. That is partly because emphasis is placed on speed of handling and ship turn-round time by one set of advocates and on installation costs by the other. All the factors—installing and maintenance costs, handing costs and ship turn-round time—are economic ones, however, and it is more useful to try to distinguish between benefits accruing locally and those accruing nationally.

The costs of installing and maintaining modern quay cranes (with tracks and power supply lines) are often usually much higher than those of installing ships' gear. Moreover, the equipping of a ship with derricks or cargo cranes has fewer implications. It is nearly always done at the time of construction; thus installation does not involve heavy expense in other directions comparable, for example, with that of widening or strengthening a quay or a river or harbour pier to make the installation of modern cranes possible. Port premises last much longer than ships and big sums of money must be expended from time to time to bring them up-to-date.

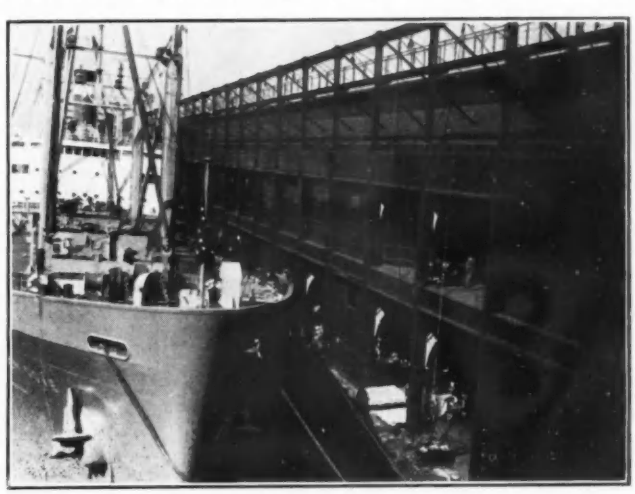


Fig. 3. Ship discharging with her gear married to house-fall. Note winch on first floor of shed.

As far as handling costs are concerned, these are likely to be less when cranes are employed, even at ports working without piecework incentives and even bearing in mind the cost of crane hire. This is because the advantages already mentioned give the crane gang the opportunity of higher outputs without increased effort. Prior to the late war, when there was less emphasis on speedy turn-round (recently a national need), shipowners weighed the cost of using quay cranes more carefully. As already stated, however, the time-in-port factor is now of such importance that if any reduction in it can be obtained by adopting one means rather than another, the quicker means is usually employed even though the cost be greater.

It is emphasised that this is the position obtaining now. At a time when international trade is small and there are more ships than cargoes, however, cheaper handling costs (often con-

Ships' Gear versus Quay Cranes—continued

Fig. 4. A recently built cargo vessel, having derricks and deck cranes as shown in Fig. 5.

and discharging operations proceed faster when they are used. Thus, where they can be installed and where speedy turn-round is required, it is desirable to have them.

However, this is by no means the end of the story. The additional efficiency of the quay cranes may not always be of such value. The revolution in goods handling methods which stems from the introduction into industry and into port work of the fork-lift truck will undoubtedly have repercussions in the sphere of handling goods to and from ship. Apart from the possibility that in the future some general cargo vessels may be equipped with side ports, there is the fact that once an appreciable proportion of ships' cargoes is packed to make it suitable for fork truck handling, ship design is likely to change sufficiently to make such handling possible and speedy in the holds. Already there is a tendency to pack goods with this method of handling in mind and ships' cargoes now include a variety of such consignments. There are, for example, palletised loads (e.g. bricks), unit loads with apertures for the truck's fork (e.g. metal ingots), goods on stillages (e.g. steel plates), packages specially built with thick bearers to ensure entry-room for forks (e.g. hardboard), and merchandise, particularly loose and

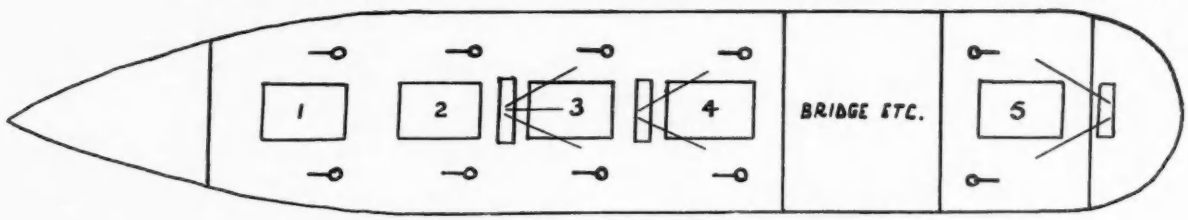


Fig. 5. "G. D. Kennedy" (Swedish), built Nurnberg 1957.

No. 1 Hold 2 Deck cranes each 3 tons at 48-ft. radius
No. 2 Hold 2 Deck cranes each 5 tons at 48-ft. radius
No. 3 Hold 2 Deck cranes each 5 tons at 48-ft. radius
2 Derricks each 10 tons
1 Derrick of 35 tons
No. 4 Hold 2 Deck cranes each 5 tons at 48-ft. radius
2 Derricks each 10 tons
No. 5 Hold 2 Deck cranes each 3 tons at 48-ft. radius
2 Derricks each 3 tons

sidered a local factor) can be more important than the saving of turn-round time of a vessel which will only make a limited number of voyages per year, anyway. This, in turn, raises the question of adapting a port to suit new conditions, the arising of which could not have been foreseen. This is often extremely difficult and thus, after a berth has been constructed, the choice of two systems of working does not always exist. This, in fact, is one reason why the arguments about the relative merits of ships' gear and quay cranes persist. Berth-owners who have not installed quay cranes and who could not do so now, at least without heavy expense, are likely to argue the merits of ships' gear (and housefalls, if provided), just as others will argue the merits of quay cranes because they have installed them and want them used.

The Future

The foregoing leads to a number of conclusions, some firm and some tentative. The United States system results from a method of port construction based partly on geographical conditions and partly on the industrial conditions existing at the time the ports were designed. In many cases quay cranes could not now be installed without additional heavy expense for other works and, perhaps, even then only if certain existing facilities were sacrificed. The European system also fits into a geographical pattern and, fortuitiously, marginal wharves and the docks so necessary in ports with a big tidal range, do lend themselves to the installation of quay cranes. It is fair to say, therefore, that the persistence of the two systems may not be the result of will and will not, but rather of can and cannot.

Nonetheless, one factor, the hoisting speed of quay cranes—stands out as of particular importance. Quay cranes can hoist their load at nearly double the speed of ships' purchases, the hoisting speeds of which are limited at a lower figure for practical reasons. It is accepted that loads usually have to travel farther on quay cranes but, bearing also in mind the big working radii of these machines, it is probably true to say that loading soft goods, in box pallets and containers with suitable bases. Fork trucks, of course, also handle cylindrical goods (e.g. reels of paper, drums, etc.) coiled goods and uncased machinery, girders and the like.

Already, too, ships are being built with level ceilings, flush 'tween decks and strong hatch covers to permit handling machines to work in the holds. Some even carry pallet trucks as part of their equipment, the truck batteries being charged from the ship's engine room.

Thus the question of bringing goods under plumb of the purchase is beginning to lose some of its importance. When fork trucks are employed, the load is conveyed from underdeck stowage and placed under the hook of the ship's crane or derrick without difficulty or loss of time. Similarly, when "fork lift truck traffic" is landed on the quay, the machine can pick it up so readily that where it has been placed is unimportant.

In circumstances such as these, port authorities and other bodies responsible for providing berth facilities (including fork-lift trucks in increasing numbers) may think more deeply before also incurring the costs of installing and maintaining expensive quay cranes. They may become more selective, limiting installation to certain berths where, for instance, there is need to plumb upper floors, especially of transit premises. It may be, therefore, that the tendency to rely more on ships' gear and particularly on deck cranes, will grow, causing a corresponding decrease in reliance on quay cranes.

It is obvious that this controversy will go on. It has been stimulated in the past by changing conditions. There will be the same stimulus in the future. If international trade continues to flourish, much money will be spent on improving handling means and change will be comparatively rapid. In a changing world, emphasis can be placed in turn upon installation costs, handling costs, handling machines, ship design and ship turn-round time. There are indications that the turn of the last-named factor is passing.

Modern Dry Docks: Design, Construction and Equipment

VIII Electricity and Electrical Installations

By T. DUNWOODY (Consulting Engineer)

(*Continued from page 59*)

Docking Winches and Capstans

Great use is made of hydraulic power normally obtained from an external supply source, for docking winches and capstans, as the characteristics of this form of drive are most suitable for the load conditions, particularly with regard to the automatic absorption of stresses on ropes, etc.

The electro-hydraulic capstan in which the power drive is hydraulic, obtained from an incorporated electrically driven pump unit, is also in general use.

Electrically driven and operated winches used in docking require both refinement in speed control, and facilities for the automatic absorption and control of line tensions, etc.

Direct current has many advantages for this purpose, and the "Ward-Leonard" system is in general use.

This method of control involves the use of a motor generator accommodated as near to the winches as practicable, the master control of the winches being from a central control console from which both sides of the dock are visible, although the individual winches can be controlled separately and locally if desired.

Cranes

A crane may be fed in either of two ways, either by means of an underground conductor rail, or by means of a flexible cable fed from a socket outlet or connection box.

A socket outlet, if this is used, is either recessed into the ground between the tracks or mounted on a pedestal. As with all other types of socket for dockside use it must be interlocked to prevent the socket being inserted or withdrawn with the control switch in the "on" position.

When a service subway is provided, the crane connection could be made within the walkway itself.

The flexible connector would then be made on to terminals contained in a sealed chamber, and controlled by a circuit breaker or isolator.

If a circuit breaker is used, it may be operated in an emergency, by rush buttons, located in the cab of the crane, and elsewhere along the route of the crane.

The method of crane control and the power drive is determined by the particular nature of the dock requirements; but in any event the crane usually is a self-contained unit, and does not call for the external connection of individual items of equipment.

Pumping Equipment

The pumphouse equipment is, of course, of paramount importance.

The advantage or otherwise of using high voltage motors for the main dewatering pumps has to be carefully considered. In a very large installation comprising a series of docks, synchronous machines for the improvement of the power factor of the complete installation may be used.

The utilisation of high voltages for pumping depends on many factors. The voltage of the incoming supply, the need to install transforming equipment, the distance between pumphouse and main intake point, and the horsepower needed for pump motors are all relevant.

Two main dewatering pumps, either of which is capable of clearing a single dock, are normally used.

To avoid a situation where both main dewatering pumps are out of action through cable failure, it is desirable to feed the pumphouse with two cables and in this event it is important that suitable arrangements be made on the Pumphouse switchpanel whereby isolation of either feeder cable can be easily undertaken. This is achieved by means of bus-section switchgear or removable links contained within the panel.

Drainage, ballast, sump, vacuum, and hydraulic pump motors, of sizes ranging from 2 to 50 h.p. must be catered for, the use of the last two pumps being dependent on the mechanical arrangements for watering and dewatering the dock.

Motors generally, must be of simple and robust construction. For simplicity of operation and maintenance, the direct-on starting squirrel cage motor has much to commend it.

Current surges arising when starting these motors, except for the largest machines, can usually be absorbed in the network.

[Photo Courtesy N.V. Phillips

Pumping room of Dry Dock at Amsterdam. Fluorescent lamps in Reflector Fittings.

Centralised control of all pump machinery is extremely desirable. The control point should, if possible, be so located at a suitable vantage point, that the operator overlooks all the machinery. Emergency stop buttons or other isolating equipment must be provided adjacent to each motor.

Lighting

Dry dock lighting may be subdivided into the following sections.

(i) Dock basin lighting, involving the provision of adequate general lighting within the dock for the hull and beneath the keel of the vessel. A level of illumination high enough for the free and safe movement of personnel is required. This general lighting would, at points where repairs are in progress, be augmented by portable units fed at 110 volts, picked up from socket outlets.

Modern Dry Docks—continued

(ii) Road lighting, calling for reasonable standard of lighting on the quays, approaches to ships'gangways and at the dock gates. For lighting of the quay areas and open spaces it is usual to provide columns or towers. The desirable thing is to have the light source as high as possible above the ground level to avoid both the risk of glare, and to give a greater spread of light from each light source.

(iii) Yard lighting, for the general illumination of the marshalling area and the areas between the various workshops.

As mentioned previously, fixed equipment at low level in the dock basin suffers alternate submersion and exposure. The choice of light fitting for this purpose has therefore inclined towards the heavy "battleship" type, complete with armour plate glass and heavy brass flanges secured by bolts to the concealed base.

Two major disadvantages of the design of this type of fitting are, it is felt, firstly, that the method of making the fitting watertight is cumbersome and slackness in the tightening of the flange bolts would cause leakage; and secondly following the heavy construction needed for this type of fitting, the working efficiency is reduced to a low proportion.

A departure from this type of fitting envisages the use of the low pressure mercury vapour fluorescent tube, contained within a watertight perspex tube. It is considered that a lightweight fitting capable of withstanding the working conditions, and able to be easily removed from its fixings, so that any repair could be undertaken under suitable conditions in a workshop, is best fitted for the purpose. Consideration of the problems suggests the use of a perspex sheath housing a 5-ft. fluorescent tube with its ancillary transformer contained in a bronze connecting end as being a solution. Such a fitting would be complete with a short flexible load and watertight plug top, and would have for its fixing two hinged clamps set into a recess in the dock structure itself. A feeder socket obviously of a watertight type, would be adjacent to each fitting. The remaining control gear and fuses for each fitting would be mounted at high level. If a service walkway is provided, they would be fitted therein.

The road lighting system normally comprises steel or concrete lighting columns, the height of which is determined by site factors, on which are mounted reflector units. Use is made of fittings mounted on the sides of the workshop or office buildings to augment the column lighting and to define, especially for ships' personnel, the path between the ship's gangway and the dock entrance. The lighting should be controlled from a series of points including the main entrance gates, nightwatchman's quarters, the normal gangway position, etc.

The lighting of quays, marshalling areas, yards, etc., is best dealt with by the provision of lightweight towers upon which are mounted a battery of weatherproof and adjustable floodlights. The disposition of these towers will depend on the crane routes and general building layout. For economy, the switch control should be mounted on a leg of the tower, if possible.

Augmentation of the lighting in areas round the crane, could be provided from fittings on the crane jib and on the main crane framework. These could be switched from both the crane cabin, and at low level on one of the crane legs.

Cargo cluster units are preferably adapted to be mounted direct on tubular standards with heavy bases. The reflectors are usually of substantial construction and of vitreous enamel finish.

Workshops

The various workshops encountered in a dry dock each demand a different approach.

The power cables to the larger motors could be paper insulated, rubber insulated, or mineral insulated cables depending on the conditions prevailing in each shop. The tendency nowadays is for all machines to be independently driven, a distinct advantage in that corresponding maximum demand is considerably decreased on application of a diversity factor.

The smaller motors could be fed by way of any one of a variety of standard overhead busbar trunking systems now available which has distinct advantages in shops where machinery is liable to be moved at intervals.

Each motor should, according to regulations, be provided with means of isolation, as close as possible to the motor itself. Interconnections between motors, starters, isolators, remote control pushbutton stations and ancillary equipment, may be in P.V.C. or V.R.I. cables in conduit, or in mineral insulated cable.

In cases where excessive vibration occurs, copper sheathed mineral insulated cables should be provided with a loop at the point of entry, to avoid subsequent breakage of the sheath.

The lighting of each workshop is planned to suit the type of operation undertaken. Heavy engineering work, as in a Plater's Shop, will as a general rule, call for a somewhat lower degree of lighting than machine shops, tool rooms, etc. It must be remembered that the statutory minimum for workshops is six lumens per sq. ft.

Care must be taken to avoid the stroboscopic effect of some forms of gaseous discharge lighting in workshops where rotating machinery is used. This is easily overcome by the provision of the correct control apparatus.

A pilot system using tungsten lamps is often an advantage to avoid the full use of the entire lighting system when cleaning or maintenance is being undertaken. It should also be remembered that some cold cathode lamps require a long restarting period once they have been switched off and when speedy restoration of lighting in these circumstances is needed, the pilot lighting system could be of use.

There is of course also the tungsten ballast circuit which would provide light from the tungsten lamp in such circumstances. A high level of general illumination is always desirable, but with some tasks local lighting is necessary. Generally speaking where this local lighting is within reach of the operative, a low voltage supply should be used.

[Photo Courtesy Benjamin Electric Ltd.

Lighting at Mountstuart Dry Dock.

Administration Buildings, Staff Rooms, etc.

The lighting and power installations in these blocks will usually be of conventional pattern.

Sound Systems, etc.

This could be classified under

(a) Conventional intercommunication telephone system linking the administration buildings, foremen's offices, gatehouse, and ship's bridge for which a dockside outlet is needed. The telephones could be of the P.A.B.X. type which combines both public telephone system and internal telephone communication or the separately installed G.P.O. telephones and the privately obtained internal telephone system.

(b) The Public Address System is of value in two ways, one for staff location and the other for the amplification of berthing instructions sometimes carried out with the assistance of loud hailers. The Public Address System could also be used to indicate working breaks, etc.

(c) Other devices such as clocks, time recorders, fire alarms, etc., are dealt with as site exigences demand. It should be borne in mind that some form of automatic fire detection appara-

Modern Dry Docks—continued

[Photo Courtesy Holophane Ltd.

Typical dock lighting scene planned to provide adequate directional illumination by pristmatic reflectors without harassing glare.

tus, coupled with an automatic extinguisher system may well be needed in High Tension Switchchambers, etc.

Materials and Components

Having dealt with the various applications of electricity, the attributes of the principal materials and components can be considered and the application to various uses encountered in Dry Dock procedure.

Switch and Fuse Gear, etc.

The design and type of the switchgear, fusegear, and starting equipment, to be used, will be decided by the space available, its location, and inevitably, cost. The larger switchboard units may be of the modern cubicle design, or the traditional unit type in which the various items are separately mounted on an angle iron framework, fixed to the wall or floor.

All equipment should be of the heavy industrial type, mechanically robust, and of adequate capacity. All gear should be capable of withstanding the heavy short circuit currents that can flow under fault conditions, and for this purpose, as a general rule, all fuses should be of the high rupturing capacity pattern.

Cables

The type of main feeder cables to be used will also depend on site conditions. For normal underground use these would be of paper insulated lead covered type, armoured and served. The alternative rubber and plastic cables are at a disadvantage only because of their lower current carrying capacities. Wire or tape armouring for underground cables is essential because of the risk of mechanical damage.

The use of paper insulated aluminium sheathed cables has become fairly popular in dock areas, but soil conditions, where such cables are buried, have to be investigated to ensure that corrosive elements are not present. Jointing methods for aluminium sheathed cables follow a different technique from that for lead covered cables.

Mineral insulated metal sheathed cables, employing either copper or aluminium for the outer sheath, are now widely used, but could be subject to corrosion. Where it is suspected that such a risk arises, the cable should be of the P.V.C. sheathed type. It is sometimes overlooked that water percolating into plantrooms may contain dissolved corrosive elements, particularly where made-up ground contains cinders or ashes, and where this water comes into contact with the metallic protection of the electrical system, rapid deterioration may occur.

The magnesium oxide insulation of mineral insulated cables, is subject to breakdown at exceptionally high voltages such as may be induced by the making and breaking of large motor circuits. To circumvent this, the starting apparatus of such equipment should be fitted with " Metrosil " or similar surge absorbers.

Poly-Vinyl Chloride or Polythene insulated cables, are resistant to the deleterious effects of oil and water, and are better than vulcanised rubber insulated cables for this purpose.

There have been many recent developments in synthetic rubber production. A popular new type, Butyl rubber, is capable of withstanding high temperature, and is also ozone and moisture resistant. Butyl rubber insulated cables can be provided with a chemically inert sheathing of Poly-Vinyl-Chloride or Polychloroprene and can be provided with armouring, in addition.

It follows that this type of cable would be suitable for alternating total immersion and subsequent exposure, such as for low level dock basin lighting and keel line socket outlets.

Flexible cables should be kept to a minimum in length and quantity and should be adequately maintained.

The leads to cargo clusters, portable electrical machinery, handlamps, etc., must be thoroughly inspected and tested at frequent and regular intervals.

Cables used for temporary ships' leads are in many cases supplied by the dock owners. In these cases and where ships provide their own leads, rigid inspection should always precede their connection.

Lamps

Consideration of the type of lamp to be used in lighting is governed by capital expenditure, life of lamp, colour characteristics, running costs, etc.

The gaseous discharge lamp has a long life, the present figures being 5,000 hours for the fluorescent tube, and 10,000 hours for the cold cathode lamps. These lamps need control gear.

Tungsten lamps are cheaper, but have a life at normal operating voltage in the region of 1,000 hours. The light output from a tungsten lamp is less than that for the gaseous discharge variety of the same wattage.

For some fixed installations, gaseous discharge lamps show advantage in running costs. No general rule can be laid down, and it is usual for an analysis of cost, etc., to be made for each application.

It may be said that the sodium vapour lamp has very good characteristics for area lighting especially as far as acuity of vision is concerned.

Its great disadvantage is that the light is monochromatic and distorts all colours to a greater or lesser degree, and has an adverse effect on the appearance of the human complexion.

Whilst the degree of adversity as far as the latter is concerned is a matter of opinion—and some experts say, psychology—there is no doubt that it is impossible to match colours accurately under sodium vapour lighting, and painting operations are therefore difficult with this light source.

The degree of distortion is so marked that it is also hard to distinguish metals, or their alloys by sight.

Various means have been devised to prolong the arbitrarily decided life of the tungsten lamp, mainly by using lamps of a higher voltage rating, and thus under-running them, with consequent diminution of light output.

Such economies may be of value where large numbers of lamps are used, but the amount of saving is debatable.

Maintenance

An important factor in design of any installation must be ease of its future maintenance.

The working areas around switchgear, starters, and other electrical machinery and equipment should be kept clear of obstacles.

Adequate clearance must be maintained on access sides of all equipment.

Wherever possible, maintenance on equipment which can easily be removed from its fixings or casing should be undertaken in the workshop.

To assist in maintenance, the standardisation of components as far as possible is essential, and specially made parts should be avoided as far as circumstances will permit. A properly organised store and workshop are of course vital, as is also a properly kept log of all routine inspections and repairs.

Coastal Experiments with Radioactive Tracers

Recent Work on the Coast of Norfolk

By W. J. REID, B.A., B.A.I. (Hydraulics Research Station, D.S.I.R.).

RESEARCH work on coastal problems has always been hampered by the difficulty of establishing the direction and rate of movement of mobile material. Recently a new technique, using radioactive tracers, has been developed by means of which the movement of mobile material can be followed. This technique has already been used on several occasions in this country.[1, 2]

This article describes further work in which radioactive tracers were used to trace the movement of sand off the coast of Norfolk during 1957 in connection with an investigation into the erosion of this coastline. This work was carried out by the staff of the Hydraulics Research Station of the Department of Scientific and Industrial Research in co-operation with the Isotope Division of the Atomic Energy Research Establishment at Harwell. The Isotope Division was responsible for the injection of the radioactive tracer and for the preparation and maintenance of the detection unit.

Erosion of the Norfolk Coast

The protection of the north-eastern coast of Norfolk from erosion by the sea has always been difficult. Between Weybourne and Happisburgh (see Fig. 1) soft clay cliffs up to 200-ft. high face the sea and these have suffered severely from erosion since early times. The coast has been estimated to have retreated 2 or 3 miles since Roman times[3] and just east of Sheringham the rate of erosion has averaged 3-ft. per year between 1838 and 1949[4]. From Happisburgh to Winterton the low lying land near the coast is protected by a range of sandhills which have several times been breached by the sea. In February, 1938, for example, the dunes were breached at Horsey and 7,500 acres of low-lying land behind the dunes were flooded by the sea. The coast from Winterton to just north of California is again composed of dunes, but here the dunes and the beaches are wide and the coast is stable. Further south, between California and Caister-on-Sea, there are more soft clay cliffs which are up to 50-ft. high and are eroding rapidly in places. Average rates of erosion as high as 12-ft. per year have been recorded[4] between 1904 and 1942.

The rapid rate of erosion of this coast is due partly to the softness of the clay cliffs and partly to the direction in which wave and tidal currents attack the coast. Near Sheringham the direction of littoral drift divides[5], and beach material is moved from this point westwards into the Wash and south-eastwards towards Winterton. This movement occurs because the largest waves approach Sheringham from the north-north-east and cause littoral drift to the west and to the south-east; the tidal currents may assist in this movement, since the residual tidal currents change direction at Sheringham[6].

In recent years, and especially since the 1953 floods, many sea defence works have been built in the area. Concrete seawalls, groyning systems and various kinds of permeable revetments have been built to protect the towns between Weybourne and Happisburgh and the coast near Caister. A system of groynes has recently been constructed from Waxham to Horsey[7] to build up the beach and reduce the likelihood of the sandhills being breached again as they were in 1938.

It can be seen that erosion is a serious problem on the north-eastern part of the Norfolk coast. It is especially serious between Weybourne and Happisburgh, where many towns built at the top of the cliffs are threatened by cliff erosion, and at Caister where the rate of erosion is unusually high and the railway line is in danger. In spite of the many defence works which have been built there are still sections of the coast which continue to erode; and in several places the building of defence works has increased the rate of erosion on the down-drift side of the defended area.

The Sandbanks off the Norfolk Coast

The sandbanks off the coast of Norfolk influence the rate of erosion in several ways. They cause waves to break and thus absorb some of the wave energy approaching the coast; they regulate to some extent the direction of the tidal currents and it seems just possible that there is an exchange of material between these banks and the coast. Such an exchange may occur where the coast change direction at Winterton since there is a considerable amount of material in movement south-eastwards along the coast at Winterton, but a shortage of material at Caister, just south of Winterton. It is tempting to assume that some of the material eroded from the coast north of Winterton finds its way onto the offshore banks, and is carried there by tidal currents.

It was decided that a closer investigation should be made of the behaviour of these offshore sandbanks to see how they had changed in the course of time and to find out if they were stable or mobile features.

The sandbanks off the coast are cigar-shaped and lie north-west to south-east parallel to the direction of the tidal currents; they are present on the sea floor up to 60 miles from the coast. The banks are up to 30 miles long and some of them rise to a height of 90-ft. above the neighbouring sea bed which lies at about 100-ft. below chart datum. The mechanism responsible for the formation of these banks is unknown but they may be the result of the splitting up of parabolic sandbanks formed perpendicular to ebb and flood tidal currents, as originally suggested by Van Veen[8] to explain the formation of similar banks off the Dutch coast. The Haisborough sand and Hammond Knoll are still parabolic in shape and may be slowly changing into parallel banks.

Fig. 1.

Coastal Experiments with Radioactive Tracers — continued

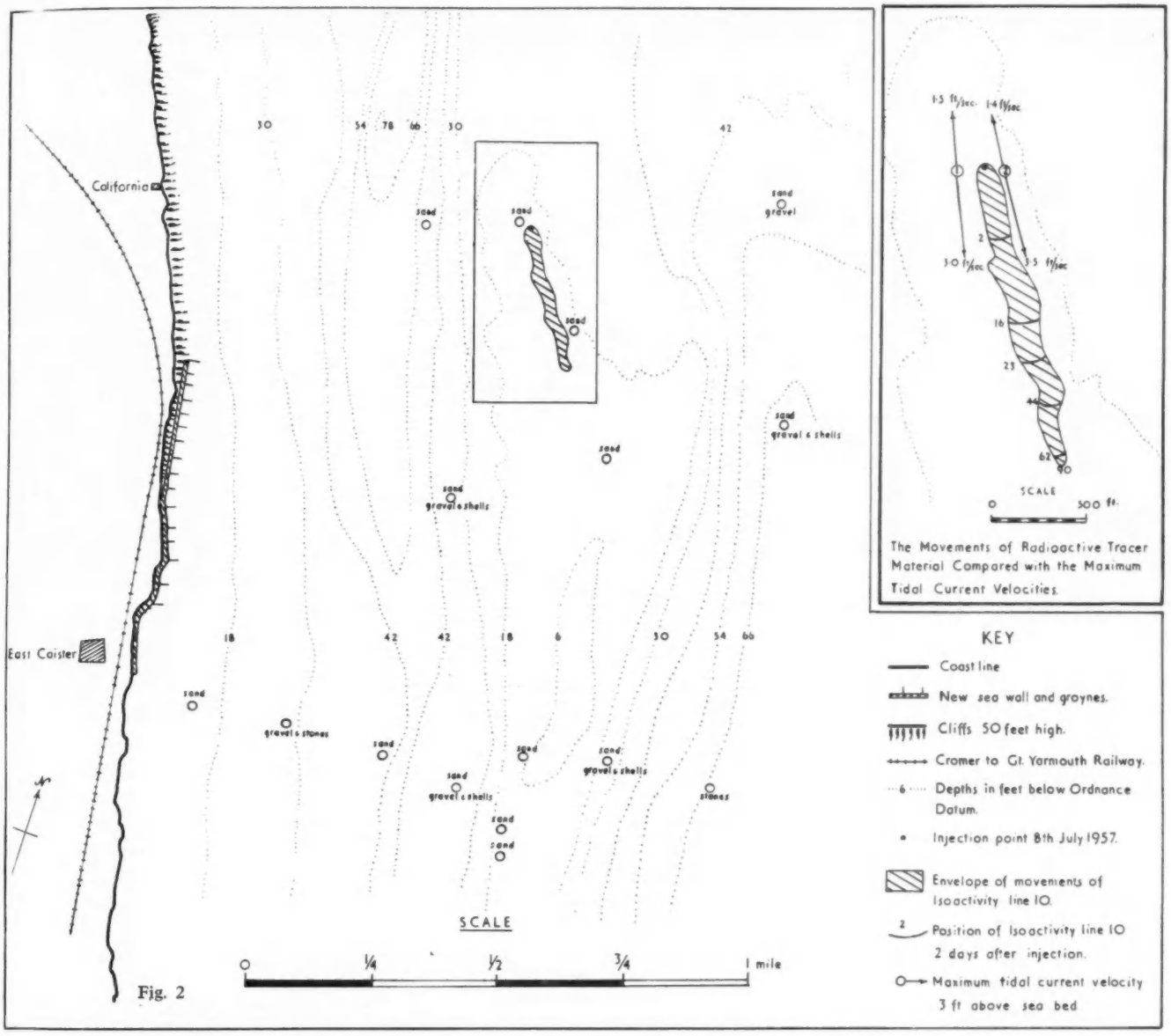


Fig. 2

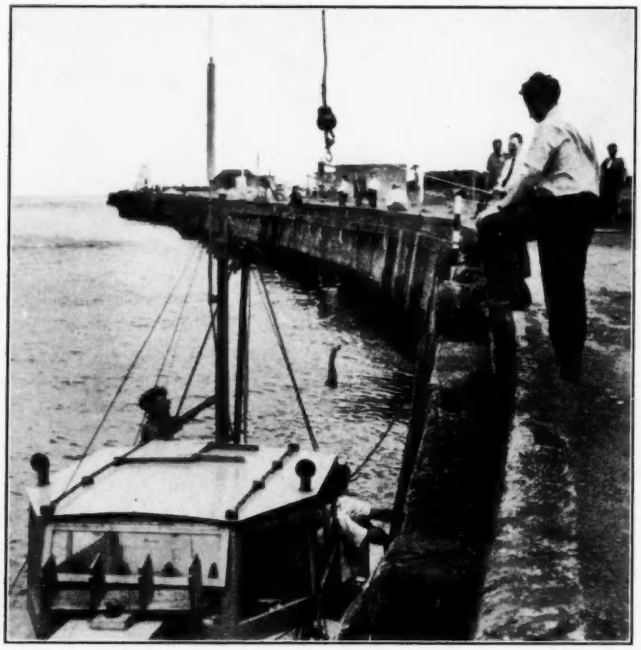
A series of Admiralty Charts showing the position of these banks at frequent intervals between 1843 and the present day was examined. The charts were copied photographically and reduced to the same scale so that the positions of the sandbanks could be compared. It was found that on the whole the banks had been extremely stable and that most of them are in exactly the same position now as they were in 1843. Some have changed position slightly without altering shape; one of the Hewett Ridges, for example, has moved 1 mile towards the north-west—away from the coast. An interesting development has occurred at the southern end of Winterton Ridge where a new sandbank, known as Hearty Knoll, has grown since 1843. This new bank seems to be part of the parabolic system of banks starting from Haisborough Sands, and it may be that this system is producing a new series of sandbanks caused by differential flood and ebb flow. Hammond Knoll, which is part of this system, has moved north-eastwards a distance of about half-a-mile since 1843.

Generally the sandbanks are stable features with the exception of an area off the coast near Winterton. At Winterton Overfalls the banks are extremely mobile and change their positions almost from year to year while maintaining the same overall shape. The most unstable area is the northern end of Caister Shoal, south-east of Hemsby Hole, where the sandbank forms and disappears at irregular intervals, while at the same time there are changes in the neighbouring banks. In this area there are strong tidal currents and often the water is very disturbed[9]. It was decided that the behaviour of Caister Shoal deserved more careful study and field experiments were planned. The choice of this area for the experiments had the advantage that it was near an area of severe erosion (at Caister) and could be conveniently reached by the station's survey launch when based at Great Yarmouth; it was also near enough to the shore to allow the position of the launch to be exactly fixed by taking sextant angles to objects on shore. The possibility of using Decca navigation had been investigated but it was found that sufficient accuracy could not be obtained.

Caister Shoal

Caister Shoal is aligned north to south, has a length of about 3 miles, and rises 45-ft. above the general level of the neighbouring sea bed. The southern end of the bank is relatively stable and is connected to the beach near Caister while the northern end, as we have seen, is unstable. A study was made of the bed material and sixteen samples were taken from the bed of the

Coastal Experiments with Radioactive Tracers — *continued*



The injection device full of radioactive material being lowered by crane into the survey launch.

shoal, some with a Van Veen Grab, and some with a Holme Vacuum Sampler. The positions from which these samples were taken are shown on Fig. 2. It was found that the material on the top of the bank was medium quartz sand with a mean diameter of about 0.35 mms.; stones, gravel and shell fragments were found on the sides of the sandbank.

Fieldwork with Radioactive Tracers

The movement of sand on the top of Caister Shoal was investigated with the aid of radioactive tracers. On 8th July, 1957, 60 gms. of radioactive scandium glass was placed on the top of the shoal opposite California—the exact point is indicated in Fig. 2. The subsequent movement of this tracer material was followed at intervals for a period of three months. A description of the techniques and equipment used for this experiment follows; although similar techniques have been used before[2], this was the first time that substantial movements of off-shore sand were successfully traced.

Preparation of Radioactive Tracer

After an examination of the available radioactive isotopes, scandium 46 was chosen as the most suitable tracer material for the experiment. It had a convenient half-life of 84 days; a high specific gravity activity (saturation 790 millicuries in an atomic pile with a flux of 10-in. neutrons per cm.^{2} per second) and it produced strong gamma radiations, with energies of 0.89 and 1.12 MeV., from almost 100% of its disintegrations. It may be noted that 1 MeV gamma radiation is sufficiently strong to penetrate 3-in. of wet sand and still retain half its energy. Another advantage of using scandium 46 was that scandium oxide, from which scandium 46 can be produced by irradiation, could be incorporated in glass capable of being transformed into particles of the same size and weight as those of the sand on the sandbanks.

Four and a half gms. of scandium oxide were combined with 300 gms. of boron-free soda glass by heating to 1400°C. This mixture was then poured into water to break up the glass into small fragments. These were then ground with a pestle and mortar until the particles were similar in size to those of the sand of the sea bed. By a process of continual sieving and grinding a sufficient amount of scandium glass was produced which had a grain size distribution similar to that of the sea sand (mean grain diameter, 0.35 mms.) and whose particles were the same size and about the same weight as the sand. It was felt that this material would be moved about on the sea bed in exactly the same manner as the sand. Sixty gms. of this ground glass containing 1½% of scandium oxide was then irradiated in a pile at the Atomic Energy Research Establishment at Harwell and placed on the top of Caister Shoal on July 8th, 1957. The total activity at the time of injection was 1.2 curies.

Injection Device

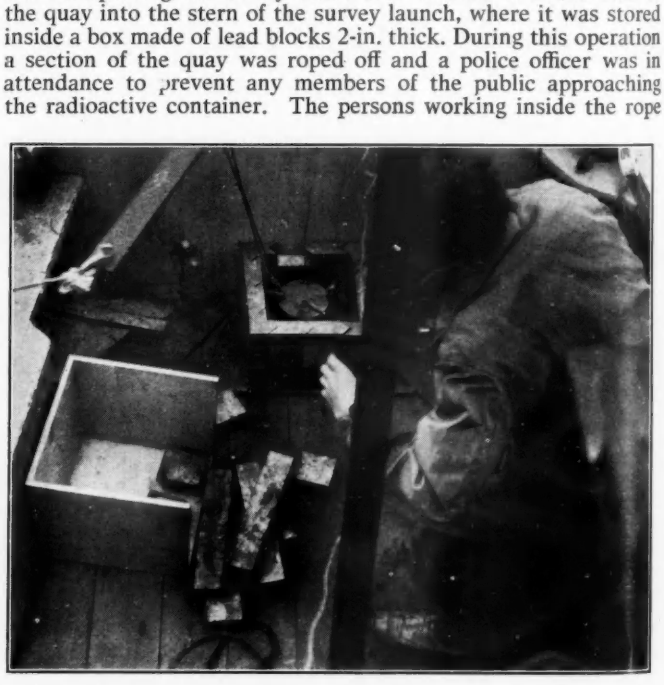
A previous experiment, carried out on the south coast near Poole in 1955[2] had shown the difficulty, and the desirability, of placing the radioactive material directly on the sea bed. Accordingly an injection device was designed in co-operation with A.E.R.E., Harwell. This consisted of a brass cylinder 6-in. high and 3½-in. in diameter with a lead casing 1-in. thick around the cylinder to reduce the external radiation. The base of the cylinder was secured by a special release mechanism which could be controlled from the survey launch. When tested the device was found to work satisfactorily in up to 60-ft. of water.

Detection Unit

The movement of the radioactive material on the sea bed was followed by a special detection unit which was similar to the device originally used at Poole. The unit consisted of a metal-sledge on which three Geiger-Müller tubes were mounted in a shock-proof casing. This sledge was dragged along the sea bed by a 150-ft. chain attached to the survey launch, which was able to proceed at a speed of about 2 knots during tracing operations. The Geiger-Müller tubes in the sledge were connected to a ratemeter in the survey launch by a length of miniature cable inside a waterproof hosepipe. The radioactivity on the sea bed could then be recorded directly on the ratemeter in the survey launch. It was found that the sea bed in the neighbourhood of Caister Shoal was very uneven and as a result the detection unit did not work well until the sledge had been considerably strengthened and modified so that it would work correctly either way up.

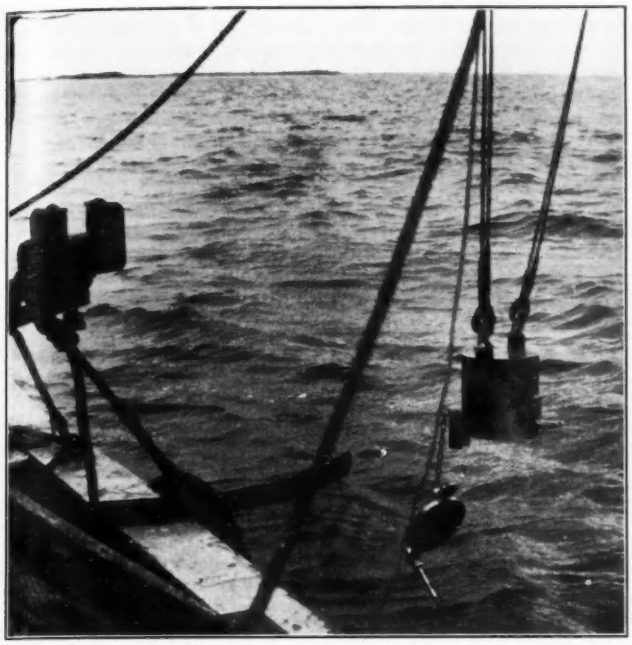
The Experiment

On July 7th the radioactive material was placed in the injection device at A.E.R.E., Harwell. The material was transported by road to Gorleston Quay, near Great Yarmouth, where the Station's survey launch was berthed, and was then hoisted out of the transporting vehicle by crane and lowered over the side of the quay into the stern of the survey launch, where it was stored inside a box made of lead blocks 2-in. thick. During this operation a section of the quay was roped off and a police officer was in attendance to prevent any members of the public approaching the radioactive container. The persons working inside the rope



The radioactive material being placed behind a 2-in. wall of lead.

Coastal Experiments with Radioactive Tracers—continued



The injection device being hauled in after the radioactive material had been deposited on the sea bed.

barrier were provided with pocket ionisation chambers on which any radiation they might receive was recorded. After the injection device was secured in the stern of the launch it was carefully examined to ensure that the radiation from the lead box did not exceed the safety level.

At 11.30 a.m. on the morning of July 8th, the launch left Gorleston and arrived over the injection area on Caister Shoal at 12.30 p.m. By 2 p.m. the current on the sea bed measured with a Watts current meter, was found to be almost slack. The injection device was hoisted over the side of the boat, placed on the sea bed which was about 15-ft. below the water surface, and the release mechanism was operated. The device was then raised and hoisted on board and when tested was not radioactive, showing that all the radioactive material had been deposited. A survey carried out next day of the radioactivity on the sea bed showed that all the radioactive material was deposited in one place.

For the next three months Caister Shoal was surveyed at intervals to test the radioactivity on the sea bed. The results of these surveys are shown in Fig. 2. The shaded area shows the limit of the movement of most of the radioactive material. When the radioactivity on the sea bed, recorded on the ratemeter in the launch, was greater than 10 radiation units after correction for decay and for background radiation it was considered that radioactive glass had been found. It may be noted that the background radiation was found to vary with the depth of water, being up to 25 radiation units above the surface and about 16 in 20-ft. of water. This was due to the absorption of soft cosmic radiation in the top layers of water. In consequence the correction for background radiation was 20 in 3 to 5-ft. of water and 16 when the water was over 5-ft. deep.

The shaded area is bounded by a line which is the envelope of the movements of the isoactivity 10 contour. The south side of this contour was found to move progressively southwards and its position 2, 16, 23, 44, 62 and 90 days after July 8th is shown. Fig. 3 shows the rate of increase with time of the distance between the point of injection and the southern limit of the spread of most of the radioactivity. The rate of movement is roughly parabolic and the decrease in the rate of movement with time is thought to be due to the dispersion and burial of the radioactive material.

Some isolated patches of radioactivity were also found, towards the end of the period of study, up to one mile south of the point of injection. However, no radioactivity was ever found either north, east or west of the shaded area.

While the experiment with radioactive tracers was in progress observations were made of the strength of the wave and tidal forces most likely to move material on the sea bed. It was hoped that an automatic wave recorder could have been placed on Caister Shoal to record wave lengths and periods, but unfortunately one was not available at the time of the study. The period, height and direction of approach of the waves were observed instead on the north pier of Great Yarmouth and on the beach at Caister. The wave conditions varied considerably during the study but the direction of wave approach was usually between north and east, the wave periods about 10 seconds and the height on breaking of the highest waves about 5-ft. Measurement of the tidal currents on the sea bed near the point of injection over a complete tidal cycle were made on 16th July and 27th August (see Fig. 2, inset). The measurements were

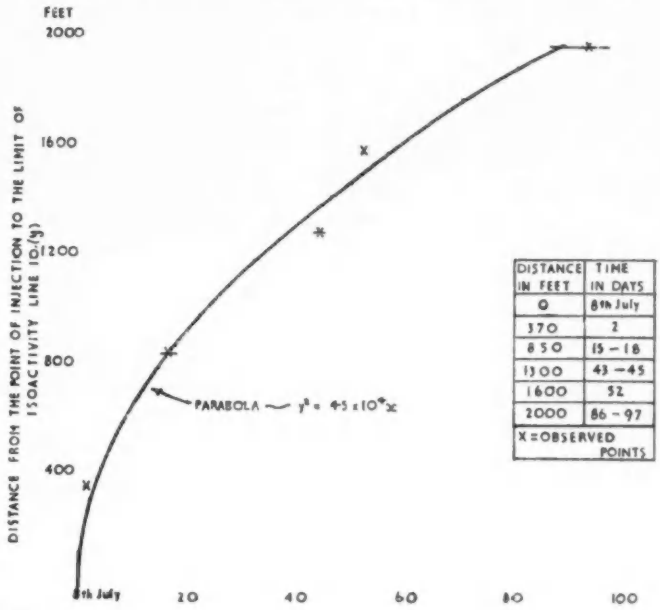
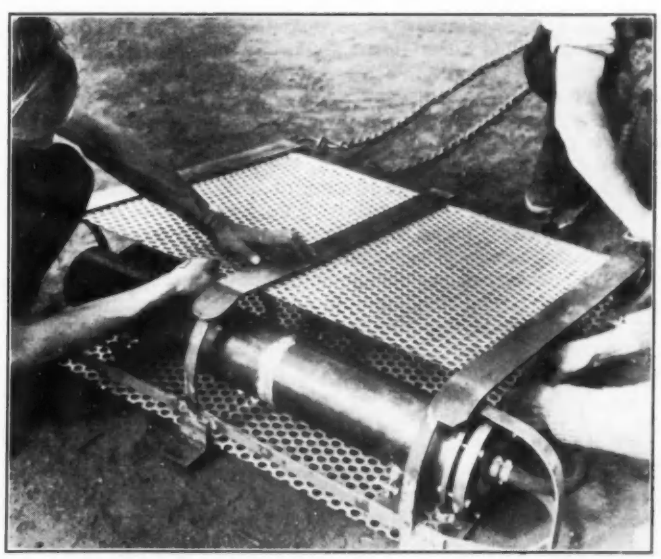


Fig. 3.



The sledge which was dragged along the sea bed behind the launch. Note the brass cylinder which contains three Geiger Muller tubes.

Coastal Experiments with Radioactive Tracers—continued

made with an Ekman current meter—giving current direction and velocity—suspended from the survey launch and 3-ft. above the sea bed. On the first occasion there was a spring tide with a range of 7-ft. at California. The maximum flood velocity was found to be 3-ft. per second at high water when the stream was flowing southwards; the maximum ebb velocity was 1.5-ft. per second northwards about 3 hours before low water. On August 27th, when there was a spring tide with a range of 10-ft., the maximum flood velocity was 3.5-ft. per second southwards and the maximum ebb velocity 1.4-ft. per second northwards. A velocity polygon plotted for the currents throughout a tidal cycle showed that the resultant drift was southwards at 0.72-ft. per second.

Results of the Experiment

The tracing of the movements of material on the top of Caister Shoal showed that the material moved at least 2,000-ft., and perhaps up to 1 mile, south of the point of injection. No material was found north of the point of injection and it may be deduced that the direction of movement was always southwards. This movement seems to have been relatively unaffected by wave motion—no material moved shorewards as it might have done under the influence of wave drift, and although wave conditions varied considerably during the period of study there was no corresponding change in the rate of movement of the sea bed material. This suggested that although the waves undoubtedly assisted in putting the sea bed material into suspension they did not cause the material to move in any particular direction. When the envelope of movement of the radioactive material was compared with the direction of the flood tidal current it was seen that all the radioactive material moved in the direction of the flood tidal current, and we concluded that the movement of material on the top of Caister Shoal was chiefly influenced by the direction of the flood tidal currents.

Acknowledgments

The author would like to thank the Director of the Hydraulics Research Station for permission to publish this article. He is most grateful to Mr. D. B. Smith of the Isotope Division at Harwell and to Mr. M. J. Crickmore and members of the survey team at the Hydraulics Research Station for their continual co-operation in this work.

REFERENCES

1. "Radioactive Tracers in the Thames Estuary," by F. H. Allen and J. Grindley. "The Dock and Harbour Authority," January, 1957, p.p. 302—306.
2. "Radioactive Tracers for the Detection of Offshore Beach Movements": Report of a Pilot Experiment at Poole in 1955; H.R.S. Paper, 1957.
3. Victoria County History of Norfolk
4. Report by the Norfolk County Planning Officer, December, 1953, Appendix 1.
5. Prof. J. A. Steers, "The Coastline of England and Wales." p. 345.
6. Atlas of Tides and Tidal Streams, British Isles and Adjacent Waters, Residual Circulation Chart 5057, published by the Admiralty, 1946.
7. E. Suffolk and Norfolk River Board. Fourth Annual Report, March, 1956, Page 16.
8. J. Van Veen, "Onderzoekingen in de Hoofden," 1936.
9. North Sea Pilot, Part III. p. 200.

Publications Received

Revision of Shipbuilding and Ship-repairing Regulations

The Minister of Labour and National Service has published a revised version of the Preliminary Draft Shipbuilding and Ship-repairing Regulations. The purpose of the Regulations is to safeguard the health and promote the safety of persons employed in the shipbuilding and ship-repairing industry.

The original version was published in 1950 and comments were invited from representatives of the organisations and bodies chiefly concerned. Discussions in recent months with a number of organisations including the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions, indicated the need to make substantial changes to the original draft. In view of this, the Minister has decided to publish a revised version so that those concerned may have a further opportunity of considering the amendments before the Regulations are published as a statutory draft under the procedure set out in the Second Schedule to the Factories Act, 1937.

The proposed new code is more comprehensive than the current Shipbuilding Regulations, made in 1931, which do not apply to ship-repairing undertaken in harbours and wet docks. This work is covered by the proposed new regulations, while among other important new provisions in the proposed new regulations are requirements as to the fencing of dry docks, guard rails on staging, precautions to be taken against explosions and fires on oil carrying vessels, and a regulation allocating responsibility for observance of each of the regulations.

The Ministry express the hope that any observations will be received not later than 31st July 1958, so that a statutory draft can be published later in the year. Copies of this Preliminary Draft can be obtained from H.M. Stationery Office or through any bookseller, price 1s. 6d. net, 1s. 8d. post free.

Revised British Steel Wire Rope Standards

B.S.S. 236/57 Steel Wire Ropes for Colliery Winding.
B.S.S. 330/57 Steel Wire Ropes for Colliery Haulage.
B.S.S. 302 and 621/57 Steel Wire Ropes for Crane and Excavators.
B.S.S. 329/57 Steel Wire Ropes for Lifts and Hoists.

Last year a comprehensive revision was made of the British Steel Wire Rope Standards covering the general demand of the mining and engineering trades with the object of rationalising the sizes and constructions in use and relating these to technical improvements in Wire and Wire Rope Manufacture.

The salient features of this revision are as follows:—

The size of the rope is now based on diameter whereas formerly it was based on an approximate conversion from circumference. Ropes to the new standards are thus closer to size but generally lighter and of lower breaking strength. The effects of this are particularly noticeable in the case of haulage ropes, which have traditionally tended to be full to size, and with flattened strand constructions. Factors of safety therefore require careful study, also the question of fitting and splicing.

To simplify the tables, round strand rope constructions have been formed into four groups within which emphasis is given to the use of Seale or equal laid construction. Flattened strand ropes, however, have an additional table covering the more flexible constructions.

Tensile ranges are generally limited to 100/100 and 110/120 tons/sq. in., the exception being lift and hoist ropes where 70/80 and 80/90 tons/sq. in. are standard, and certain haulage ropes using 80/90 tons/sq. in.

The use of basic quality steel is permitted for all rope specifications. This is due in part to the limited supply of acid quality and to the improvement in the quality of basic. Physical test requirements for acid and basic are identical and basic can therefore be used with confidence. The use of acid, however, will still be advisable for special duty ropes.

The galvanising specification has been spilt between a heavy coat weight (B.S.443) combined with lower physical wire properties and a lighter coat weight on wire having the same physical properties as ungalvanised wire (B.S.2763).

Every effort has been made to simplify these standards. For instance, B.S.302 and 621 covering the engineering rope trade have been amalgamated, and all reference to fathoms and plough steel, etc., discontinued.

The four revised British Standards for Mining and Engineering Ropes are also fully explained in a booklet (No. 147) recently issued by British Ropes, Ltd., Doncaster. The introduction of standards has inevitably brought changes in Specifications, which are adequately explained in the booklet, thus enabling the reader to assess the main differences between the old standards and the new. This publication should materially assist every rope user in the ordering of wire rope for specified duties.

Third International Harbour Congress at Antwerp

Wide Range of Papers Discussed

By E. LOEWY, B.Sc.(Eng.), M.I.C.E.

The Third International Harbour Congress, sponsored by the Royal Flemish Institution of Engineers, was held in Antwerp from the 16th to 21st June last. There was an attendance of nearly 600 congress members from some 25 countries, although British members numbered only about 20.

The proceedings were conducted in Flemish, English and German, with simultaneous translation, and the papers presented and discussed, of which there were some 60, were grouped into five main sections. A wide range of visits to maritime installations and construction projects was available, as well as a special assembly of mechanical handling equipment organised by the Belgian Committee of the International Cargo Handling Co-ordination Association, who had taken advantage of the occasion to hold a cargo handling convention. Certain social functions also took place, including a municipal reception and a banquet attended by H.R.H. the Prince of Liège, and a visit to the Brussels Universal World Fair.

For a great many years after the emergence of Belgium as an independent nation state in 1830, most education and professional training was restricted to the French language, despite the fact that 60 per cent. of the population was Flemish. The acceptance of a full system of education using the Flemish language came only in this century, but has now brought to maturity the first generation of fully Flemish-trained engineers. This is, of course, not a case of strident nationalisation or multi-national separatism but, essentially, a matter of cultural and linguistic survival and development. The Royal Flemish Institution of Engineers, which embraces most kinds of professional engineers as is customary on the Continent, has now been in existence for thirty years and can be justly proud of its own distinctive contribution to engineering and to the nation.

Although the Antwerp Congress is the third harbour congress convened by the Institution, it has marked a new departure in the scale, scope and international character of the convention, as was assumed appropriate to the 30th anniversary of its foundation.

The scope of the Congress was very wide and the five sections dealt respectively with:

1. Harbour construction.
2. Harbour equipment.
3. Handling and storing of cargo.
4. Safety in harbours.
5. Harbour management.

The respective chairmen of the section were:

1. Mr. N. Koomans, Director of the Port of Rotterdam.
2. Mr. A. Bolle, General Manager of the Port of Hamburg.
3. Mr. V. le Gorgeu, Director of the Port of Dunkirk.
4. Mr. P. W. Martin, Deputy General Manager of the Port of London Authority.
5. Mr. O. Leemans, Director of the Port of Antwerp.

Section I

The largest number of papers was submitted in Section I, Harbour Construction. They covered the planning and construction of different forms of transit sheds, the problem of shed floor design and construction, the use of light alloys for large span sheds, silo construction, berths and basins for large tankers, oil storage tank foundations, use of raking and large diameter piles, and dockside lighting.

The time available for discussion of the papers was generally far too short to do justice either to the papers or to the views of those attending, which was scarcely surprising in view of the range of subjects and the wide experience of the audiences.

Despite the considerable variety and differences of operation between ports, even in any one country, on the subject of transit sheds and quayside layout one could perhaps generalise that Continental practice and thought favours single-storey sheds between 100 and 200-ft. wide, of minimum height 20-ft. and with the least possible internal supports; quayside aprons at least 100-ft. wide with 3 to 5 rail tracks; and dockside cranes at least 70-ft. reach. The familiar debate continues regarding the adoption of raised platforms for transit sheds either on the landward or on both sides, as opposed to having the shed floor flush with general ground level all round. This important matter has of course been argued and discussed in journals, textbooks and conferences for many years and wide differences of view and strong prejudices were again evident during this Congress. The latest Dutch and Belgian practice favours the shed floor flush all round, while the French approach still prefers the landward rail platform usually adopted in the United Kingdom and the Commonwealth. German, and to some extent Scandinavian practice, still strongly favours the raised platform on the apron side.

Shell concrete construction has now long challenged steel frameworks and a good example was available for inspection at the wharf used for the I.C.H.C.A. exhibition. Elsewhere a remarkable shed of 250-ft. span by 800-ft. length and built of composite steel and light alloy was displayed. Even this exceptional structure was stated to have cost only thirty shillings per sq. ft. inclusive. In general, however, the steel lattice truss or portal frame is still preferred and a British example quoted was of welded 2-pin portal design. 170-ft. span with exceptionally low specific steel weight.

Shed flooring problems received much attention, with the Dutch and Belgian members re-emphasising their familiar preference for the factory-made, pre-cast steel-edged slabs. A considerable industry now exists to manufacture these units and to provide both standard pieces and special slabs for surfacing at points and crossings. The general view of members outside this "tradition" was that simplified in-situ variants would provide adequate and much cheaper floors. Methods of raising floor slabs which have settled were discussed, and a caution given regarding non-uniform slab loading, when using mud or cement grout pumping.

The latest climbing shutters with centralised hydraulic actuation were described in the paper which reviewed progress since 1930 in reinforced concrete silo construction.

The paper and discussion on the foundations for storage tanks in soft ground covered the usual range of opinion, with the prevailing view that piling was generally to be avoided. The advantages of vertical sand drains to accelerate the consolidation of soft layers was re-emphasised by many speakers.

The papers on the provision for berths for supertankers reviewed the latest installations, both existing and under construction or consideration, in European harbours. Most of the major ports are likely to be effectively limited to the 65,000-ton tankers, due to limitations of approach channels, though new projects in remoter situations (e.g. Milford Haven, Finnart, Europoort) are planned for 100,000 d.w.t. vessels. Details of new berths for supertankers were described and an interesting divergence of design practice between Belgian and other European engineers became apparent. Whereas most new berths in the English-speaking world and in Holland, Germany, etc., provide for the maximum flexibility, the latest designs for Antwerp adopt rigid monoliths. The advantages of the single large-diameter steel tube dolphins and of the "berthing beam" type of berth were explained in discussion. In favourable circumstances, a single-tube dolphin suitable for 45,000 d.w.t. ships has been built in Rotterdam harbour for £10,000. In difficult circumstances, a complete "berthing beam" berth has been built overseas for £60,000.

The history and development of the Port of Matadi was recounted in a paper which described the exceptionally high gravity wall adopted for the Kala-Kala wharf and the use of 50-in. diameter bored piles using Benoto hammer grabs and the Benoto oscillatory in-situ pile-making process for shed foundations. The paper on raking pile systems described, in particular, the use of 1:1 rakes for both permanent and temporary construction.

Two excellent papers on lighting, gave an interesting review of current Continental practice. Objections to the use of sodium vapour lamps owing to their monochromatic light are gradually being overcome (e.g. special inks and dyes for marking). The importance of shielding lights from the view of crane drivers was frequently emphasised.

Third International Harbour Conference at Antwerp—continued

Section II

Section II, Harbour Equipment, contained unusually thorough reviews of systems of tug boat propulsion showing, in particular, the unique advantages of Voith-Schneider propellers which are to be adopted for the latest Antwerp tugs.

Another paper described the new oil-hydraulic transmission for crane motions which has been adopted for the latest Antwerp cranes and which will be used at the Matadi extensions. The quay arrangements for the Danish provincial traffic using ships with side ports for direct entry of trucks to the holds was described and its wider adoption discussed.

An exhaustive analysis of the static and dynamic stability of floating harbour craft was given in two papers. Two further papers reviewed the latest devices for weighing cargo on weighbridges, on cranes and on belts.

Section III

This Section, devoted to cargo handling, contained several rather general papers on modern methods of cargo handling, as well as more specialised papers on jet fuel hazards, bulk sugar handling, carbon disulphide problems, fruit and quick-frozen fish and a scientific analysis of the causes of loss and damage to various classes of cargo.

Section IV

Section IV which dealt with safety in harbours, contained the largest proportion of contributions in English and provided several papers on the problems of cleaning and gas-freeing tankers and the related subject of removing oil pollution from harbour waters, where, it may be said, United Kingdom ports are ahead of the Continent. Other papers described port radar installations, sanitary problems, fire-fighting arrangements and air pollution.

Section V

This section, on harbour management, contained several papers on the influence of industrial development upon port operation policy, which gave rise to much serious discussion on the benefits to be obtained from actively encouraging industrial expansion within port areas and, also, on the dangers and restrictive effects that may result from a too-ready grant of sites alongside deep-water to industries which, eventually, fail to utilise such sites properly. These matters led to consideration of leasehold policy, restrictive covenants, rent policy and provision of services.

The influence upon port policy of town and regional planning was discussed at length and the general conclusion reached was that the Port Authority must retain 100 per cent. control of development and planning within its own area of jurisdiction, subject only to any broad economic policy laid down by Government.

The effect on port operation of the declining importance of rail traffic was also debated. In the main North European ports the importance of inland water traffic is increasing everywhere and this tends generally to ease the demands for shed and warehouse space and for increased road transport facilities. Where there is a "straight" competition between rail and road transport, it is general to find almost 100 per cent. use of road transport for journeys up to 100 miles.

An informative paper was also given on signalling systems in ports for the remote control of installations as well as for calling and communications. Use of pilot lines and of the main power network was explained with examples from the practice in Antwerp and Brussels.

The Congress closed with a formal session which brought together the various resolutions and conclusions of the different sections.

Visits and Social Events

A bewildering array of visits to factories, marine establishments and works under construction was provided for most of the afternoon sessions, the first being a conducted tour of the docks. This was taken on board a river steamer which gave a vivid impression of the great extent of the docks system and the intense activity. Noticeable were the many fine cranes, the large modern fruit shed equipped with special conveyors and chutes, the array of coal transporters, the complicated lifting bridges, the growing petroleum industry and the efficient control installations at the new Baudouin Lock.

The National Hydraulics Laboratory showed a large hydraulic model investigating the effects upon the Antwerp entrance channels of the Dutch Delta Scheme, as well as smaller models studying such problems as the unstable bar in the Scheldt near the docks.

The new No. 5 Wet Dock Basin, under construction adjacent to the existing No. 4 Basin, will be a mile long by a quarter mile wide and provide generally 36-ft. of water. The whole of the work, which is being carried out under contract in two stages, is being done in the dry using a system of well points for ground water lowering. The excavation, totalling nearly two million cu. yds. is being done mainly by draglines and all the material dredged will be used to raise the general ground level around the basin. Most of the quay walls are of conventional mass concrete gravity section, but over one length of half a mile, where factories will be sited and the water depth will be limited to 20-ft., the construction is of the "Danish" type using Franki piles. The soil consists of sands and sandy clays.

Another visit was to the factory of the Boom Metalworks at Boom, which though founded only in 1921, has built up an enviable reputation for first-class excavating plant and harbour cranes as well as general engineering products. The design of the plant seemed generally very sound if orthodox, with emphasis on robustness and quality. The latest dockside cranes have pressed and welded superstructures like other Continental makers. For the first time in the world, all motions are hydraulically driven using Mannesmann variable delivery oil-hydraulic pumps and motors. Some of these cranes are in use in Antwerp harbour and others will be provided for the Matadi extensions.

The principal social function was a banquet attended by Prince Albert, Duke of Liège, who has taken much interest in the Institution's progress and in the Congress in particular. During this occasion, a decoration was conferred upon Mr. R. F. Bocxstaele, the General Secretary of the Institution, in recognition of his 30 years' service since its foundation, and for his work in connection with the organisation of the Congress.

New Ferry Services Between Australian Ports

It has recently been reported that the Australian Shipbuilding Board has invited tenders from Australian shipyards for the construction of a vehicle and cargo carrying ship at a cost of £A. 1 million. The vessel, which will be operated by the Australian National Line, has been designed to accommodate 61 semi-trailers, in addition to about 30 cargo containers. Her dimensions will be length 320-ft., beam 56-ft., draft 14½-ft. and gross tonnage 2,550. Six lines of vehicles or containers are to be carried on the upper deck and five on the main vehicle deck. Cargo containers and new motor vehicles will be carried in the hold. Shore cranes will be provided at each port for lifting cargo to the upper deck, and Melbourne, Tamar (Launceston), Devonport and Burnie have been selected as ports of call. It is expected the vessel will complete two round voyages, calling at the four selected ports, each week.

Meanwhile, the Bass Strait car and passenger ferry which is being constructed at the State Dockyard, Newcastle, for the Australian National Line at a cost of £A 1,500,000, is expected to be in operation in November next year sailing between Melbourne and Tasmania. This ferry will be equipped with radio-telephone, mainly for contact between the ship, her agents and the Line's headquarters. Also, a V.H.F. system of short-range harbour control communication with a range of about 50 miles will enable harbour masters at the terminal ports to issue berthing directions to the ferry. The vessel will be fitted with Voith-Schneider propulsion at the bow in order to give increased manoeuvrability. Three round voyages will be made each week, with provision for an additional crossing during seasonal peak periods.

In order to accommodate the new ferries, work is currently being carried out on the port terminals. In Melbourne, at the River Entrance dock site, where there is already sufficient depth of water, filling and levelling operations are in progress. At Devonport a large dredging programme is in hand and construction of the new berth will be commenced early next year.

Pneumatic Unloading of Grain at Cork

New Discharging Installation Completed

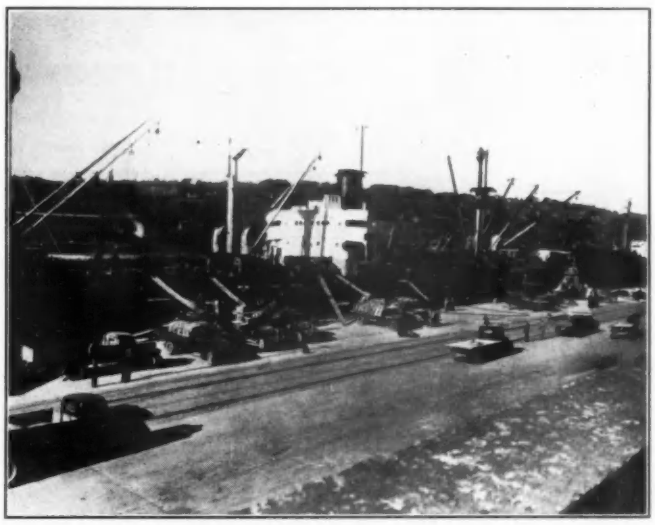
(Specially Contributed)

At the Port of Cork, there is now in operation an efficient and up-to-date installation for the pneumatic discharging of grain from ships at a total maximum rate of 240 tons per hour. Designed and built by Simon Handling Engineers Ltd., for the Cork Grain Discharging Company Ltd., it consists of two travelling pneumatic plants, with associated conveying equipment, feeding four silos and, as at present constituted, may fairly be said to represent ten years of continuous work. However, this statement requires the important qualification that, for the last seven of those ten years, pneumatic unloading has been successfully carried out concurrently with associated developments, including considerable quay reconstruction and extension of silo facilities. How this ten-year task was carried out may best be described stage by stage and the story serves as an interesting example of how obstacles in the way of modernisation and improvement can be overcome by planning, flexibility of method and intelligent collaboration.

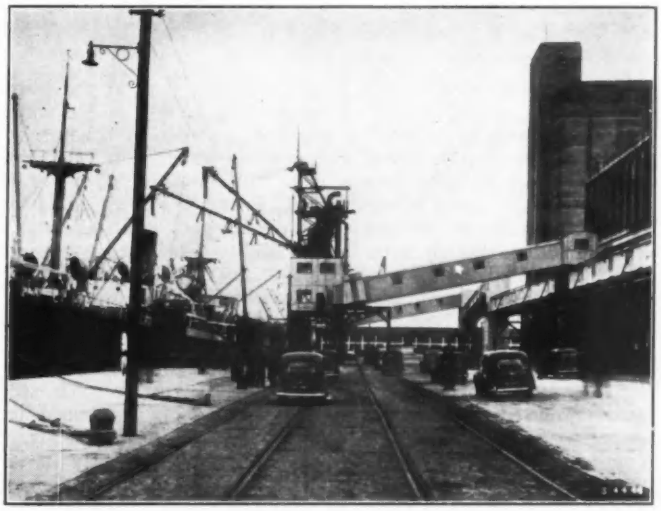
Work on the installation began in 1948. At that time, the methods employed at Victoria Quay for discharging grain were extremely cumbersome and wasteful of time and labour. Buckets were lowered into the holds to be filled manually, then hauled up and emptied into a portable bag-filler waiting on the quay. The bags were loaded on to lorries or horse-drawn carts and taken to the silos only a short distance away, where they were cut open and their contents emptied into the hoppers. It was obvious that pneumatic discharging would effect considerable saving in expenditure of labour and material, throughout the entire process. First of all, the manual labour employed to fill buckets would no longer be required, as the pneumatic nozzles would reach every corner of the hold; secondly, time and labour involved in filling and emptying sacks would be completely eliminated and, thirdly, as grain would be transferred to the silos through a conveying system, the need for transport across a distance of a mere hundred feet or so would be obviated.

There were more advantages than this to be derived from the installation of the new plant. Pneumatic discharging enables unloading to be carried on in all weathers, as the ships' hatches need only be opened enough to allow for the entry of the pipe nozzles; overheated grain may be cooled off in passing through the air-trunking; travelling plants may be moved into the most suitable position for unloading; the use of two plants enables two holds to be emptied simultaneously and little labour is required for "trimming." Considerations such as these made the installation of a pneumatic discharging system a highly desirable proposition.

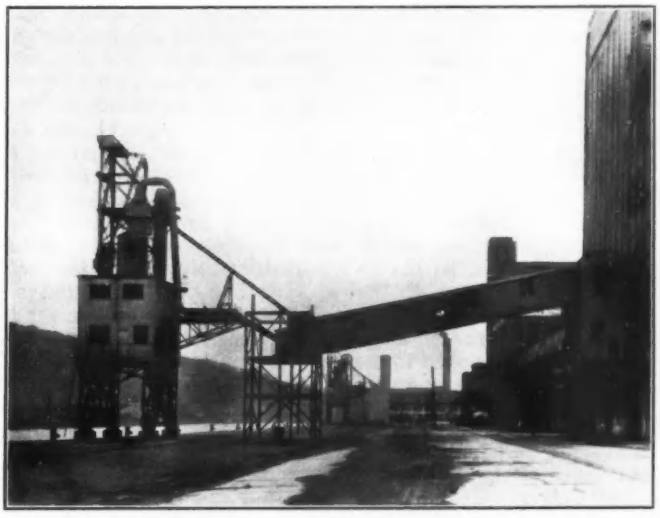
By July, 1951, the new installation was in operation. Two pneumatic unloaders were used, both at that time fixed in position, but designed for easy conversion into travelling plants at a later stage. Each plant incorporated the normal Simon design features, which may be briefly described. The plant is in the form of a tower, carrying the intake pipes and booms, the receiver and tipper seal, the dust collecting plant and the control gear; sometimes the plant also contains the vacuum pumps but, at Cork, these are housed with the motors in a separate pump house on the quay and connected to the plants by air-pipes on the cross gantries. Each plant at Cork has two intake pipes and associated booms; the pipes are highly flexible and capable of reaching into all parts of the hold of a ship with their nozzles, which incorporate a valve for regulating the amount of extra air entering the suction pipe in addition to the air entering through the nozzle with the grain. The receiver is essentially a large vertical cylinder with a hopper-shape base, and it is here that the grain is separated from the air-stream, the grain falling into the hopper and the air being drawn off to the vacuum pump through an outlet at the top of the cylinder; the tipper seal is a device for releasing the grain from the receiver without allowing air to enter and break the vacuum. The vacuum pumps used are of the double-acting reciprocating type, driven by electric motors through reduction gears.



The discharging arrangements in 1948; lorries and horse-drawn carts receiving bags of grain for transport to silos.

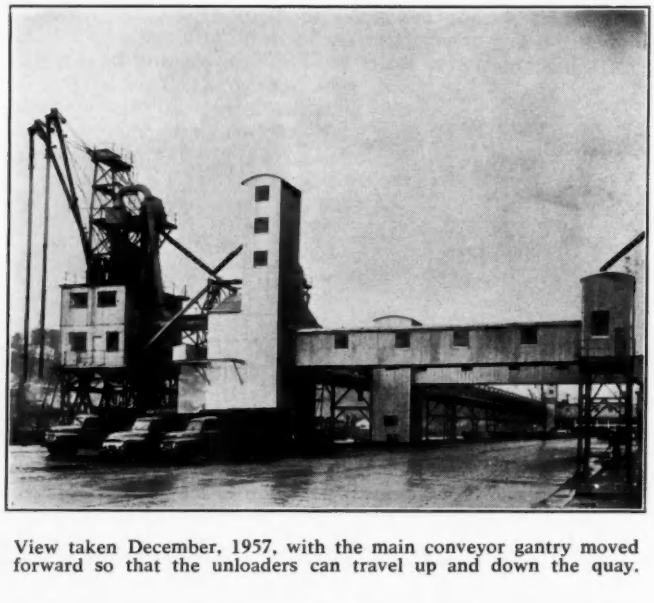


The new installation in 1951. The unloaders are set well back and fixed to the quay.

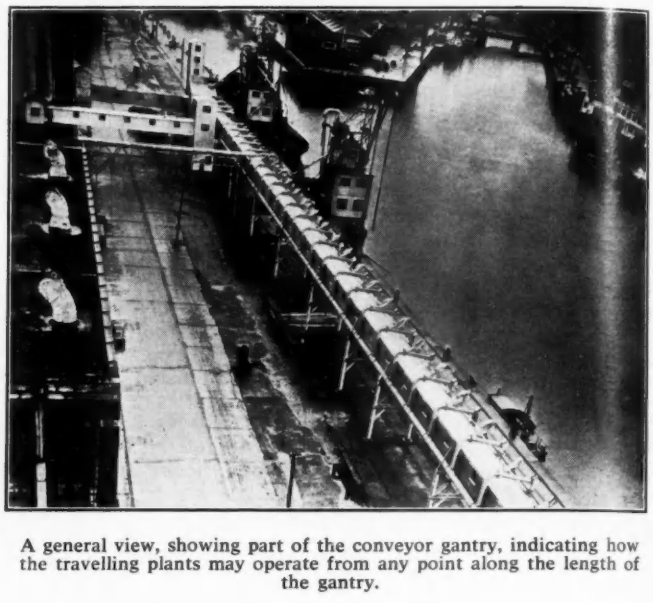


The rebuilt quay, January, 1957. The unloaders have been moved forward, but the conveyor gantry is still located alongside the silo buildings.

Pneumatic Unloading of Grain at Cork – continued



View taken December, 1957, with the main conveyor gantry moved forward so that the unloaders can travel up and down the quay.



A general view, showing part of the conveyor gantry, indicating how the travelling plants may operate from any point along the length of the gantry.

At this time (1951) it was found that the quay at the waterside was not strong enough to support the weight of the travelling plants and an extensive quay reconstruction scheme was scheduled; meanwhile, the plants were set back about 30-ft. from the quay and the pipe booms were strengthened, to allow for their unusually large span of 60-ft. From this position it was possible for them to operate without interruption throughout the reconstruction though with less flexibility than they were later to achieve when free to travel up and down the quayside. The installation as it functioned during this period is interesting as a kind of "half-way house" between the old conditions and the present-day arrangement.

The main conveyor gantry ran alongside the main silo buildings of which there were then only two (the number has since been increased to four); this gantry, in effect, comprised two associated conveyors. The first, measuring some 640-ft. in length, was capable of conveying grain simultaneously in two opposite directions; the shorter of the two (measuring approximately 120-ft.) carried only one stream of grain at one time, but was made reversible to allow for greater flexibility. Fixed in position at right-angles to the main conveyor gantry, were two cross gantries on to which grain was discharged from the plants and which in turn transferred it to the main conveyors. Even at this stage, the conveying system was flexible and was designed not only to pass grain efficiently from ship to silo, but also, when desired, to transfer grain supplies from one silo to the other.

The ultimate aim was, of course, to move the plants and main conveyor gantry to the edge of the quay, and work was now begun at the waterside on the extensive reinforcement of the quay that was essential before this development could be carried out. Thanks to nature and positioning of the two plants, it was possible to continue discharging during the period of reconstruction; in the later stages, each plant was dismantled in turn and set up again in a forward position on the reconstructed portion of the quay, so that at least one plant was always in operation at any time and both plants were functioning for the greater part of the period. It should be mentioned that, when the plants were moved to the forward position, they were erected on bogies, in preparation for the final conversion into travelling plants.

By the end of 1956, the reconstruction of the quay had been completed and it now remained to carry out the final stage of the scheme: the transformation of the fixed plants into fully mobile plants, capable of travelling up and down the quayside and discharging from any position. To do this, it was necessary to reverse the relative positions of the cross gantries and the conveyors running alongside the silos; that is to say, whereas, up to this point, the plants had discharged onto fixed cross gantries which in turn passed the grain to conveyors alongside the silos, the latter now had to be moved forward to the quayside, from which position they could discharge onto the cross gantries leading to the silos, of which there were now four. By the end of last year, this had been done and the installation was complete.

The main conveyor gantry now runs alongside the quay and, as before, consists of two conveyors; the first still continues to operate simultaneously in two directions, the second is still reversible. Along the length of the main conveyor gantry, spout and air pipe connections are fitted at intervals, which means the two plants may now travel up and down, couple up to the conveyor gantry at almost any point along its length and, working independently or simultaneously, direct grain into any one of the silos. The main conveyor gantry passes the grain to four cross gantries, leading to the four silos. Two of the cross gantries are reversible conveyors, a fact which increases the overall flexibility of the conveying system. Here again, it is not only possible to direct grain to any silo from any position along the quayside; it is also possible to effect transposition of grain supplies between certain of the silos.

The installation is already proving of value, not only in effecting the more obvious economies in time and labour, but also in speeding-up the turn-round of ships and therefore cutting down costly delays. Cork can now offer those advantages already enjoyed by many other grain-receiving ports using similar installations, in some cases on a very large scale, not only in Great Britain, but also in Paris, Brussels, Bergen, Rio de Janeiro and other ports all over the world, where pneumatic handling has proved itself to be one of the most flexible and economic means of moving material in bulk.

New Dry Dock for Tyne

A large dry dock is to be constructed by Vickers-Armstrongs (Shipbuilders), Ltd., near their existing dry dock at the Palmers Hebburn shiprepairing works on the Tyne. The dimensions of the new dock will be 850-ft. long with an entrance width of 145-ft. and depth over sill at H.W.O.S.T. of 35-ft. Initially it will accommodate oil tankers of up to 80,000 tons d.w.

Designed so that extensions can later be made lengthening the dock by 150-ft. to accommodate larger tankers up to 120,000 tons d.w., the new dock in its first stage is planned to be open and ready for use by 1961. Messrs. T. F. Burns & Partners, London, are the consulting engineers and the contractors are Marples Ridgway & Partners, Ltd., London.

Flexible Steel Dolphins and Kindred Structures

Survey of Recent Developments in the Netherlands

By Ir. Tj. J. RISSELADA
(Chief Engineer of the Public Works Department of Amsterdam, Chief of the Department of the Harbour Works.)

(*Continued from page 54*)

(e) Future Development

Although the progress of supertanker building is a matter for admiration, it is a source of ever-increasing worry to harbour authorities. Some years ago the problem of the increasing draught of vessels resolved itself into the problem of enabling ships with a draught of up to 40-ft. to reach the various ports. At that time, the tanker carrying about 40,000 tons was the limit; since then, however, their development has continued at a tremendous rate.

The uncertainty regarding navigation through the Suez Canal has undoubtedly been one of the relevant factors influencing the growth of the size of tankers. Having now become familiar with the thought of tankers carrying 100,000 tons, one asks oneself if this is really the limit.

As it is an incontestible fact that these giant tankers can only put in to a few harbours, the problem has to be faced as to the extent construction of new harbour basins to accommodate this kind of tanker is necessary and economically justified, or whether they should be dealt with in another way, for example, by concentrating their berths in a few (partly new) harbours and, consequently, transporting and distributing their cargo on a much larger scale by pipelines. It will be clear that in such a case, the geographical and nautical suitability of berths must be the determining factor, and that the influence of economy must predominate over that of frontiers.

Another problem bound up with the one above is how these giants can be berthed safely. Since the turn-round of these costly ships is so important, it is essential that the terminal facilities meet the requirements of speed. Hence it is clear that a solution providing the tanker with a fixed berth near a causeway and pipeline bridge, effecting the ship to shore connections rapidly and with ample capacity, is preferable to one where the tanker is moored to buoys and must be connected to submarine pipelines.

In the last few years there has been considerable development in the design of flexible steel dolphins, utilising the latest available high-grade steel sections. Examples of such dolphin designs have been worked out and consist of either one single Mannesmann tube or a number of broad-flange Peine piles for berthing tankers with a displacement of 100,000—135,000 tons (about 75,000—110,000 tons dwt.).

Two principal cases are considered: case A, in which the tankers are in an enclosed dock (tidal range nil), and case B, in which they are moored in an open tidal basin (tidal range=16-ft. 5-in. (5 m.)).

A berthing velocity of 5 in./sec. (12½ cm./sec.) has been assumed in the first case and of 6 ins./sec. (15 cm./sec.) in the second. The results are given in Table VII.

Although the table is not meant as a

TABLE VII.

	Design data, Requirements and Data of the structure	Unit	Per dolphin					
			Case A		Case B*		Case B**	
			type		type		type	
			Peine	Mann	Peine	Mann	Peine	Mann
Design Data:	Depth of water	ft. (m)	49 (15)	49 (15)	from 49 to 69 (from 15 to 21)	from 49 to 69 (from 15 to 21)	from 49 to 69 (from 15 to 21)	from 49 to 69 (from 15 to 21)
	Angle of internal friction	degree	25	25	25	25	25	25
	Displacement	tons	100,000	100,000	135,000	135,000	135,000	135,000
	Speed of berthing	ins./sec. (m./sec.)	5 (0.125)	5 (0.125)	6 (0.15)	6 (0.15)	6 (0.15)	6 (0.15)
Requirements:	Energy-absorption at 20″ (0.5m.) + H.W.*	ft. tons (mt)	180 (55)	180 (55)	350 (105)	350 (105)	350 (105)	350 (105)
	Static load at 10 ft. (3m.) + H.W. (under the most unfavourable direction)	tons	150	150	200	200	250	250
Data of the structure:	Number of piles		3 × 6	1	4 × 8	1	4 × 9	1
	Section/diameter (external)	ins. (mm)	PSp 60 S (see fig. 23)	63 (1600)	PSp 60 S (see fig. 24)	73 (1860)	PSp 60 S (see fig. 25)	85 (2150)
	Thickness of wall	ins. (mm)	— —	1½ (38)	— —	2 3/16 (55)	— —	1 7/8 (47)
	Yield stress of the highest grade of steel used	tons/sq.inch (kos./sq.cm)	22.7 (3600)	28.6 (4500)	22.7 (3600)	28.6 (4500)	22.7 (3600)	28.6 (4500)
	Length	ft. (m)	108 (33)	111 (33.85)	136 (41.35)	139 (42,4)	137 (41.7)	154 (47)
	Weight	tons	99	40	209	83	248	84
	Energy absorption at 20″ (0.5 m) + H.W.**) α=the angle with respect to the normal to the front at which the force acts. α=0°	*ft. tons* (*mt*)	*417* (*127*)	*186* (*56.7*)	*735* (*224*)	*350* (*105*)	*889* (*271*)	*350* (*105*)
	α=20°	ft. tons (mt)	299 (91)	186 (56.7)	568 (173)	**350** (**105**)	702 (214)	350 (105)
	α=45°	*ft. tons* (*mt*)	*203* (*62*)	*186* (*56.7*)	*397* (*121*)	*350* (*105*)	*509* (*155*)	*350* (*105*)
	α=70°	*ft. tons* (*mt*)	*144* (*44*)	*186* (*56.7*)	*266* (*81*)	*350* (*105*)	*328* (*100*)	*350* (*105*)
	f/p : flexibility at 20″ (0.5 m) + H.W. (normal to the front)	ins./t (cm./t)	0.256 (0.65)	0.174 (0.4)	0.174 (0.442)	0.085 (0.216)	0.151 (0.383)	0.063 (0.160)
	Static load at 10 ft. (3 m.) + H.W.; (under the most unfavourable direction)	tons	**150**	**150**	**200**	213	**254**	**250**

*In contrast with the assumptions made in earlier cases, it is assumed here that, in view of the great length of the vessels, one dolphin must be able to absorb 70 per cent instead of 50 per cent of the total kinetic energy.

**It is assumed that the forces pass through the centre of gravity of the structure.

Flexible Steel Dolphins—continued

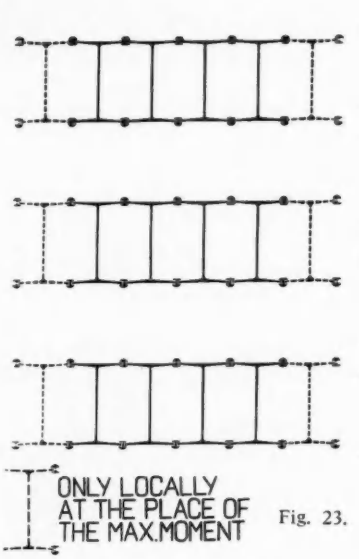


Fig. 23.

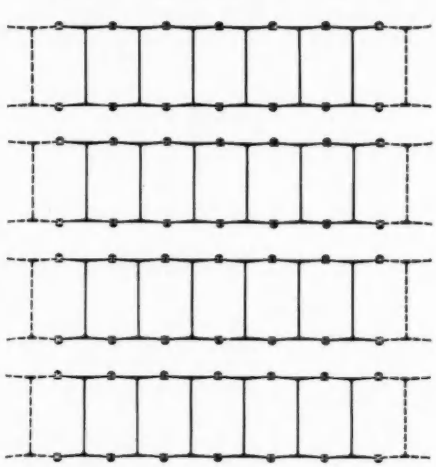


Fig. 24.

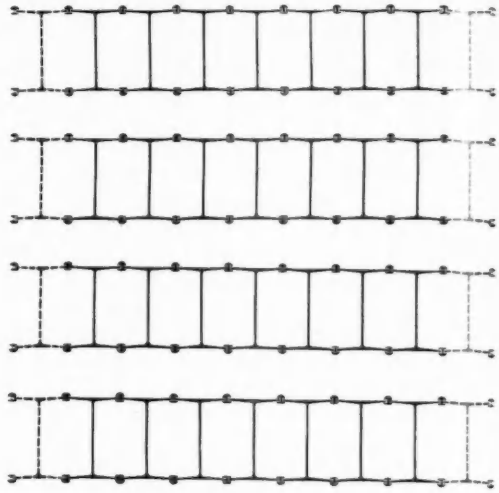


Fig. 25.

comparison between different sections, one can draw the following interesting conclusions from it:

(a) For very large dolphins, the static loads appear to be the determining factors when non-tubular sections are used; whereas when tubular sections are used the dynamic loads are generally the critical ones.

(b) If non-tubular sections are adopted, it is of the highest importance to scrutinise and to specify very carefully the angle α at which the vessel may hit the structure.

It is evident that when structures with a still higher energy-absorption are required, it will be necessary to adopt designs with more than one tubular pile. The same applies if a higher flexibility is desired, which can be achieved with a number of piles of a smaller diameter. It is true this will have little or no influence on the weight of material required for the piles — and therefore on the cost of them—but it makes bracings necessary and hence increases the ultimate cost of the structure.

Since the designs are only typical examples, the data of the structures in the table do not necessarily have any general validity.

The figures mentioned in Table VII are based on the assumption that the berth is provided with two dolphins. It may occasionally be necessary, for nautical reasons and for accommodating tankers of various classes, to use more than two dolphins per berth. Though this will imply that the static load per dolphin will be lower, it will be clear that this does not necessarily hold true for the dynamic loads, and particularly not for dolphins placed at the outer limits of a berth.

The combination of a flexible steel dolphin consisting of a number of steel piles with a gravity fender offers interesting possibilities, such as a "Baker" fender suspended at three points from the hinged brace. The mobility of the gravity fender is a special advantage in this combination since thereby the vessel will always touch the structure over a considerable area and not along a line, as is more or less the case with a structure fitted with fixed fenders. Since the energy-absorption is supplied by the steel piles and the gravity fender together, the piles of this combination can be lighter than those of the dolphin described above, whilst the gravity fender can also be lighter than one suspended from a fixed support.

(f) Conclusion

The above survey of recent developments in dolphin design shows the advantages of steel construction and shows how, by using the latest steel sections and qualities, it is possible to proceed further with such designs than with other materials used up to this time.

Proceeding from certain approximate formulae, the economic issues are set out to enable a structure to be designed which meets the various (sometimes contradictory) demands.

By showing the effect of a variation of the design data and of the angle at which the force acts on the structure, the necessity of collecting the correct design data is demonstrated. These data naturally must take account of all known geographical, meteorological, nautical and structural factors.

On the basis of a fairly extensive survey of structures which have been erected, it is not difficult to arrive at the conclusion that, under the given circumstances, designing similar structures for still larger ships, should encounter no special difficulties. This has been exemplified by the examples given of a flexible dolphin for mammoth tankers of 100,000—135,000 tons displacement (about 75,000—110,000 tons dwt.).

It is a source of satisfaction to conclude that good berths for mooring such tankers can be guaranteed in this way.

Annual Report of Wellington Harbour Board, 1957

The Annual Report of the Wellington Harbour Board for the year ended 30th September, 1957, shows that there was only a slight increase in the amount of cargo handled, the tonnage being 2,757,733. Tonnage of shipping arrivals decreased by 154,605 tons net from the previous year's record total of 4,266,229 tons, and revenue for the year fell by £63,600, mainly due to lower oversea imports. This together with an increase in expenditure of £59,755, resulted in a net loss on the year's working of £15,995. Imports of all classes (excluding transhipments) totalled 1,634,580 tons, a decrease of 2 per cent. Transhipments from British and foreign ports totalled 33,167 tons, a decrease of 23.3 per cent.; Australian transhipments totalled 21,590 tons, an increase of 36 per cent.; and coastal transhipments decreased from 68,613 to 66,364 tons. Outward cargo of all classes totalled 698,911 tons, an increase of 9.5 per cent. Exports to British and foreign ports increased by 12.3 per cent. and to Australia by 28.5 per cent. Coastal exports increased from 371,556 to 394,855 tons.

With regard to improvements during the year, the new Wool Store was completed and put into service. This is equipped with a modern press, overhead cranes, accurate weighing facilities and good lighting. The reconstruction of the Waterloo Quay Wharf with a new shed was also completed, providing the port with a further well-equipped coastal berth. The development of the Hutt Estuary reclamation scheme proceeded well and the first stage, including 47½ acres was completed. Three new mobile cranes and twelve tractors were purchased and an order was placed for an electric lifting magnet for handling pig and scrap iron. During the year, the Board approved a proposal for rebuilding the South Inner Tee of Queen's Wharf as a first stage of the reconstruction of the Lambton Basin wharves.

A Marine Exposure Test of Chemically Impregnated Poles and Untreated Controls in South African Harbours

By P. M. D. KROGH
(Officer-in-Charge of Wood Preservation, Forest Research Institute, Pretoria, Union of South Africa).

Summary

THIS paper discusses the reason for initiating the above-mentioned tests and describes a design for testing the efficacy of various wood preservatives when impregnated into wood and exposed to the ravages of wood destroying marine borers attended by other destructive factors. An indication of the efficacy of the preservatives, and the behaviour of untreated controls is given in a tabular statement, Table I; the average life in months of those specimens which have failed up to the present time is shown.

The methods of preparation and preservation of the test specimens are discussed and incomplete results due to loss of specimens in the 1953 tests are disclosed. The experience gained in the pilot investigation has proved a valuable guide for designing replicated and further work.

A biological survey of wood-destroying organisms in all South African harbours was made; the methods used and the results obtained are discussed.

Introduction

South Africa, unfortunately, is not richly endowed with forest resources, and though much is being done by the State and private enterprise to improve the position, it will always be necessary to conserve home-grown timber supplies. Owing to the need for using the non-durable thinnings from our plantations, the large quantities of timber which have to be imported and the rapid rate at which wood deteriorates in most localities of this country, conservation must always be a prime factor in our economy; thus, at a very early stage in the development of our plantations, the protection of wood by chemical impregnation became imperative.

During the past decade notable progress has been achieved in the development of preservative treatments and in the testing of the efficacy of chemicals or wood preservatives against the various wood destroying agencies. For instance, a considerable amount of work has been done on the evaluation of wood preservatives against termite attack at our Pienaars River (Termite) field exposure testing station in the Transvaal, and against decay at our station at Kruisfontein in the Knysna district of the Cape Province. The testing of preservatives against beetle attack and *Cryptotermes brevis* is conducted by the Division of Entomology in co-operation with this Forest Research Institute.

The need to start our own 'Marine' experiment, in spite of the fact that the results of similar experiments undertaken overseas are available, originated in the fact that our results of testing the efficacy of wood preservatives in other fields have not always supported such findings. Especially has this been the case with results obtained from our field exposure tests[1], at Pienaars River (termites) and at Kruisfontein (fungi), where some wood preservatives, known to be effective overseas, failed lamentably when they were exposed in contact with the ground under outdoor conditions in South Africa. Our work has shown that, while a preservative might prove to be very suitable for a specific purpose in one province or country, it can very well prove ineffective in another. For instance, water soluble salts are known to have given good service in Britain and on the Continent, but in South Africa some of these have shewn weaknesses, particularly when used for the impregnation of telephone poles exposed to the sun and weather. Unlike the oily preservatives, they afford comparatively poor protection against the twisting of spirally-grained wood and weathering, as sometimes manifested by severe surface checking. As a result of our earlier work, therefore, it was felt that the results obtained from 'Marine' tests in our own harbours might also differ from those obtained overseas. It was thus decided early in 1950 to initiate an experiment, in co-operation with the South African Railways Administration, designed to test the efficacy of the various wood preservatives and to compare these results with those obtained by exposing untreated controls, as well as untreated naturally durable timbers such as *Lophira procera, Piptadenia buchananii, Manilkara cuneifolia* etc., to attack.

If some effective wood preservative should be found, our home-grown heavy pines could be used for harbour piling, thus saving large sums of money which under present practice leave the country.

Collecting marine animals.

The Main Series of Experiments (1953)

The main investigation was initiated during 1953 in the Durban Harbour, where it was known that some of the principal species of marine borers are generally active.

It was decided at the beginning that only the efficacy of the wood preservatives was to be tested and, therefore, factors such as would arise from using a durable species of wood as the testing medium, which might very easily cause a false reflection of the efficacy of a preservative, should be eliminated. Any success shewn in a treated specimen should be ascribable solely to the preservative. For this reason *Pinus patula*, a species of timber known to be non-durable, was chosen as the medium for carrying the preservative. In South Africa *Pinus patula* trees grow at a phenomenally rapid rate[2], often attaining sawable size before heartwood has developed over any considerable radius. The test material used in this investigation was cut from suppressed 13 year old stems, an age at which development of heartwood had not commenced and therefore complete penetration with preservative was possible. A large stock of this material was procured from the Coetzeestroom plantation and stored under cover; such procedure affords a 'permanent' source of supply and eliminates the disadvantage of having to use a new and strange stock of wood, should any further extension of the work be contemplated. It also obviates bringing in an extra variable factor.

After closely examining the condition of the piles at Maydon Wharf in Durban Harbour at low tide, it was decided when planning the test at the outset that, if the specimens were to be exposed

Marine Exposure Test—continued

TABLE I

Condition of specimens of sets I and II, subjected to attack at Maydon Wharf and Salisbury Island, in Durban Harbour, Natal: after 5 years and 6 months of exposure.

Item No.	Date Initiated	Treatment. Preservative Name	Absorption in lb. per cu. ft. Dry Salt Min.	Dry Salt Max.	Oil or Solution Min.	Oil or Solution Max.	Average	Number of Specimens	Number of Specimens Lost: First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	"d" Total	Conditions of Specimens: August, 1957. Good: Number	Good: Per cent.	Attacked: Number	Attacked: Per cent.	Attacked By: Shipworms (Teredo) (Xylotrya)	Limnoria	Martesia	"b" Per cent. Destroyed	Average Life in Months
1	4.3.52	5% Pentachlorophenol in A.W.P.A. Creosote ex Iscor	—	—	7·25	12·65	9·62	9	2	1	—	—	—	—	3	—	—	6	100	—	x	x	66·7	
2	do.	do.	—	—	13·10	18·80	16·09	7	—	—	1	—	—	—	1	—	—	6	100	—	x	x	—	
3	do.	do.	—	—	22·00	23·60	22·66	8	4	—	—	—	—	—	4	3	75	1	25	—	x	—	—	
4	do.	10% Copper Naphthenate in A.W.P.A. Creosote ex Iscor	—	—	9·40	13·10	11·20	7	—	—	—	—	—	—	—	—	—	7	100	—	x	x	43·0	
5	do.	do	—	—	13·25	16·50	15·26	8	2	—	—	—	—	—	2	2	33·3	4	66·7	—	x	x	33·3	
6	do.	do	—	—	17·96	24·80	22·61	8	1	2	—	—	—	—	3	2	40	3	60	—	x	x	—	
7	do.	A.W.P.A. Creosote ex Iscor	—	—	10·40	11·98	11·20	8	—	1	—	3	—	—	4	—	—	4	100	—	x	x	75·0	
8	do.	do.	—	—	14·80	17·75	17·26	6	3	—	—	—	—	—	3	—	—	3	100	—	x	—	—	
9	do.	do.	—	—	21·86	27·15	24·20	10	—	—	—	—	—	—	—	6	60·0	4	40·0	—	x	x	—	
10	do.	"a" Copper Pentachlorophenate	1·52	1·95	—	—	1·60	4	1	—	—	—	—	—	1	2	66·7	1	33·3	—	x	—	—	
		A.W.P.A. Creosote ex Iscor	—	—	10·47	11·97	11·13																	
11	do.	do.	1·43	1·99	—	—	1·68	12	—	1	—	1	—	—	2	6	60·0	4	40·0	—	x	—	—	
			—	—	14·10	17·76	16·35																	
12	do.	do.	1·60	1·60	—	—	1·60	1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	
			—	—	19·59	19·59	19·59																	
13	do.	"c" Copper Pentachlorophenate	0·18	1·28	—	—	1·01	5	1	1	—	—	—	—	2	—	—	3	100	—	x	—	66·7	
14	do.	50% U.K. Creosote +43% Pegasus Furnace Oil A +7% Satmar Torbanite Oil and fortified with 2·5% Pentachlorophenol	—	—	6·03	10·00	8·45	14	6	—	1	—	—	—	7	—	—	7	100	—	x	x	100	41
15	do.	do.	—	—	13·36	18·57	16·68	5	—	—	—	1	—	—	1	—	—	4	100	—	x	x	75·0	
16	do.	do.	—	—	19·30	28·70	22·37	5	—	—	—	—	—	—	—	—	—	5	100	—	x	x	40·0	
17	do.	10% Copper Naphthenate in Pegasus Furnace Oil A	—	—	8·11	12·54	10·80	8	—	—	—	—	—	—	—	—	—	8	100	x	—	x	100	33
18	do.	do.	—	—	13·65	17·85	15·71	9	1	—	—	—	—	—	1	—	—	8	100	—	x	x	100	36
19	do.	do.	—	—	18·58	23·40	21·62	7	1	2	—	—	—	—	3	—	—	4	100	—	x	x	100	40
20	do.	Creosote Coal-Tar Mixture ex Iscor F.P. 4302/7 ...	—	—	8·20	11·98	9·74	9	4	1	—	—	—	—	5	—	—	4	100	—	x	—	75·0	
21	do.	do.	—	—	12·30	18·33	16·05	7	—	1	—	—	—	—	1	—	—	6	100	—	x	x	33·3	
22	do.	do.	—	—	18·54	24·10	21·35	8	1	—	—	—	—	—	1	—	—	7	100	—	x	x	28·6	
23	8.10.52	5% Celcure	0·27	0·67	—	—	0·58	7	—	1	2	—	—	—	3	—	—	4	100	—	x	x	50·0	
24	do.	do.	0·70	0·91	—	—	0·83	8	—	—	—	—	—	—	—	—	—	8	100	—	x	x	37·5	
25	do.	do.	0·94	1·17	—	—	1·03	9	—	—	—	—	1	—	1	2	25·0	6	75·0	—	x	x	—	
26	do.	A.W.P.A. Creosote ex Iscor fortified with 2% Nostrip	—	—	8·78	12·65	11·15	6	—	1	—	—	—	—	1	—	—	5	100	—	x	x	60·0	
27	do.	do.	—	—	19·20	21·70	20·55	4	—	—	—	—	—	—	—	1	25·0	3	75·0	—	x	x	—	
28	4.3.52	*P. patula*—untreated control	—	—	—	—	—	8	1	—	—	—	—	—	1	—	—	7	100	x	x	x	100	8
29	do.	*Manilkara cuneifolia* ...	—	—	—	—	—	7	—	—	—	—	—	—	—	—	—	7	100	—	—	x	43·0	
30	do.	*Lophira procera* ...	—	—	—	—	—	7	1	1	—	—	—	—	2	—	—	5	100	—	—	x	40·0	
31	8.10.52	*Chlorophora excelsa* ...	—	—	—	—	—	4	—	2	—	—	—	—	2	—	—	2	100	—	x	x	50·0	
32	do.	*Piptadenia africana* ...	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	4	100	—	x	x	75·0	—
33	do.	*Sarcocephalus diderrichii* ...	—	—	—	—	—	8	2	3	—	—	—	—	5	—	—	3	100	—	—	x	100	47
34	10.3.53	*Chlorophora excelsa* treated in U.K. Creosote ...	—	—	3·66	3·66	3·66	4	3	1	—	—	—	—	4	—	—	—	—	—	—	—	—	
35	do.	*Sarcocaphalis diderrichii* treated in U.K. Creosote	—	—	12·61	24·43	20·18	5	3	—	1	1	—	—	5	—	—	—	—	—	—	—	—	
36	do.	*Piptadenia africana* treated in U.K. Creosote ...	—	—	7·20	10·33	8·37	4	2	—	2	—	—	—	4	—	—	—	—	—	—	—	—	
37	7.10.52	*Piptadenia buchananii* ...	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	100	—	—	x	100	47
38	do.	*Piptadenia buchananii* treated in U.K. Creosote	—	—	4·04	4·04	4·04	1	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	

"a" Specimens first impregnated with Copper Sulphate and allowed to dry, then impregnated with Sodium Pentachlorophenate and allowed to dry and then lastly with creosote.

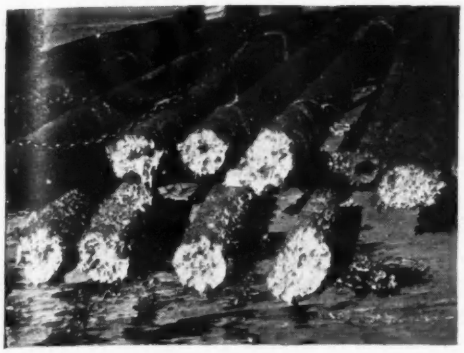
"b" When 50% or less of specimen remained anywhere in cross-section, it was classed as destroyed.

"c" Specimens first impregnated with Copper Sulphate and allowed to dry and then lastly with Sodium Pentachlorophenate.

"d" Lost specimens are eliminated from the experiment and the number of specimens in test reduced accordingly.

"x" Denotes type of attack.

Marine Exposure Test—*continued*



(Left) Shipworm attack in lower sections of specimens. (Centre) Test frame in place. (Right) New method of attaching test specimens to steel frames.

as piles to the whole range of attack by the various marine animals present in the harbour, they would have to be of a length capable of spanning the full tidal range and be placed so that their bottom ends would be permanently submerged and with about a foot of their top portions permanently in the air. The tidal range in all South African harbours is only about 6-ft., so that poles 10-ft. long satisfactory span it. There was evidence, too, that certain of the borers operated in strata related to tidal levels, and the experiment was so designed that these strata could possibly be determined.

Preparation of Specimens

The specimens as previously stated, were prepared from 13 year old *Pinus patula* stems which were allowed to air season to equilibrium moisture content of about 12 per cent. They were then cut to 10-ft. lengths with their bottom and top diameters measuring about 5-in. and 4-in. respectively. Their surfaces were wetted to facilitate the complete removal of all cambium, so that the radial penetration of preservative would not be hampered.

Impregnation of Specimens

The impregnation of the specimens was affected by submerging them in the preservative in a bath especially made for the purpose. The loaded bath was then placed into an empty pressure cylinder where a modified full-cell[3] process was applied. Control of absorption and penetration was effected by appropriate manipulation of vacua and pressures in the treating cylinder. The absorptions were calculated in pounds of preservative per cubic foot of air-dry wood. Individual volume measurements were made, as well as weighings before and immediately after final treatment. A copper label bearing the reference number of the respective specimen was securely attached to each. Along with the specimens in each charge were placed several extra ones which, at the end of each treatment, were cross-cut in order to determine whether complete penetration had taken place. Only charges which showed complete penetration were included in the experiment.

In the preparation of the copper-pentachlorophenate specimens, there was the disadvantage of having to impregnate first with one chemical, re-season and then impregnate with the other. The difficulty experienced with this method was that of having too much of one or the other preservative impregnated into the wood, and of possibly not having a complete chemical reaction taking place between all the chemical present; there would thus inevitably be free chemical in the wood which would eventually leach out. The figures for absorption of copper-pentachlorophenate in Tables I and II are thus probably somewhat higher than was actually the case.

The wood preservatives used in the final test, the results of which are given in Table I, are listed below:—

A.W.P.A. Creosote ex Iscor; Celcure; Copper Naphthenate in A.W.P.A. Creosote ex Iscor; Copper Naphthenate in Furnace Oil; Copper-pentachlorophenate; Copper-pentachlorophenate and after seasoning A.W.P.A. Creosote ex Iscor; F.P.I. Creosote Coal Tar Mixture ex Iscor; Pentachlorophenol in A.W.P.A. Creosote ex Iscor; Pentachlorophenol—Furnace Oil — Creosote Mixture.

For this investigation, a test sample of 8 was taken as standard and it was endeavoured to prepare 8 specimens for each absorption range; due to various causes, however, this was not always possible, as can be seen from Table I, sets I and II. As the result of experience gained and better planning there was rather more success with set III (see Table II).

Natural Durability Test

Along with these treated specimens, similar specimens of various untreated and treated African and other hardwood timbers were also exposed to attack. These were mostly species that have been reported to be durable when subjected to severe conditions on land, but which had not yet been used to any great extent in marine work in this country. As with the *Pinus patula* specimens, these specimens were 10-ft. long by either 4-in. diameter or 4-in. square section. They are listed below:—

Chlorophora excelsa, (Welw) Benth. & Hook.f.
Eucalyptus citriodora, Hook.
Eucalyptus paniculata, Sm.
Lophira alata, var. procera, Burtt-Davy.
Manilkara cuneifolia, (Bak.) Dubard.
Ocotea rodiaei (R.Schomb) Mez.
Piptadenia buchananii, Baker.

Placing and Fixing of Specimens

The specimens were divided into two approximately similar sets, each of which was in turn further divided into two at random. The final sets were then selected at random for fixing to the steel frames especially constructed to carry them. The fixing was done by wiring on through holes placed at the top and bottom of each specimen and holes provided in the frames. That this did not prove to be a very satisfactory method of fastenings is shown by the losses reported in Table I. A much improved method of fixing the specimens recorded in Table II was devised; each was held in place by means of saddles bolted to the frame near its top and bottom ends. Two of the frames holding the specimens of the one set of the initial division were suspended in deep water, one on either side of the Dolphin nearest Maydon Wharf facing East at Congella, while the other two were suspended from piles about 1½ miles away, in shallow water near the old sea-plane floating Customs House off the North shore of Salisbury Island. As previously stated, the frames with specimens were placed so as to span the tidal range. This method was adopted primarily in order to expose the specimens to the whole range of attack, but also with a view to obtaining a combined expression of all factors affecting the protective value of each preservative, e.g. initial toxicity or repellence, susceptibility to chemical metamorphosis and leaching and the effect of intermittent wetting.

Method of Inspection and Criterion of Failure

At half yearly intervals the frames of specimens were raised for detailed inspection of each individual specimen after cleaning. Its condition, together with the destructive agent causing failure, was

Marine Exposure Test—continued

TABLE II

Condition of specimens of Set III subjected to attack at the caisson, in Durban Harbour, Natal: after five months of exposure.

Item Number	Date Initiated	Treatment: Preservative Name	Absorption in lb. per cu. ft. of wood: Dry Salt Min.	Dry Salt Max.	Oil or Solution Min.	Oil or Solution Max.	Average	Number of Specimens	Condition of Specimens: Good Number	Good Per cent.	Attacked Number	Attacked Per cent.	August, 1957 Attacked by: Shipworms (Teredo) (Xylotrya)	Limnoria	Martesia	Per cent. Destroyed	Average life in Months
1	20.3.57	"a" Copper Pentachlorophenate...	0·90	1·29	—	—	1·11	8	8	100	—	—	—	—	—	—	—
		A.W.P.A. Creosote ex Iscor ...	—	—	17·58	20·43	19·16										
2	do.	do.	0·88	1·27	—	—	1·07	8	8	100	—	—	—	—	—	—	—
			—	—	23·65	26·34	24·55										
3	do.	"c" Copper Pentachlorophenate ...	0·86	1·39	—	—	1·17	8	8	100	—	—	—	—	—	—	—
4	do.	5% Tanalith "C" ex Hicksons Timber Impregnation Co. Ltd.	0·86	0·95	—	—	0·92	8	8	100	—	—	—	—	—	—	—
5	do.	do.	1·18	1·29	—	—	1·23	8	8	100	—	—	—	—	—	—	—
6	do.	A.W.P.A. Creosote ex Iscor ...	—	—	17·44	19·88	18·10	8	7	87·5	1	12·5	—	x	—	—	—
7	do.	do.	—	—	22·50	26·29	24·76	8	8	100	—	—	—	—	—	—	—
8	do.	10% Copper Naphthenate in A.W.P.A. Creosote ex Iscor ...	—	—	17·50	18·61	18·16	8	8	100	—	—	—	—	—	—	—
9	do.	do.	—	—	23·13	26·75	24·90	8	8	100	—	—	—	—	—	—	—
10	do.	10% Pentachlorophenol in A.W.P.A. Creosote ex Iscor ...	—	—	16·87	20·00	17·95	8	8	100	—	—	—	—	—	—	—
11	do.	do.	—	—	22·10	29·70	24·63	8	8	100	—	—	—	—	—	—	—
12	do.	10% Copper Naphthenate in Power Paraffin	—	—	15·35	17·93	16·72	8	8	100	—	—	—	—	—	—	—
13	do.	do.	—	—	21·28	24·38	22·48	8	8	100	—	—	—	—	—	—	—
14	do.	5% Celcure "A" ex Celcure & Chem. Co. Ltd.	0·90	0·98	—	—	0·93	8	8	100	—	—	—	—	—	—	—
15	do.	do.	1·17	1·39	—	—	1·30	8	8	100	—	—	—	—	—	—	—
16	do.	Sasol Creosote 70 ex Sasol ...	—	—	17·93	19·88	19·14	8	8	100	—	—	—	—	—	—	—
17	do.	do.	—	—	24·75	27·84	26·35	8	8	100	—	—	—	—	—	—	—
18	do.	*P. patula* untreated control ...	—	—	—	—	—	8	—	—	8	100	x	x	x	—	—
19	do.	*Dipterocarpus spp.* in A.W.P.A. Creosote ex Iscor (Heartwood)	—	—	8·29	19·47	12·62	9	9	100	—	—	—	—	—	—	—
20	do.	*Piptadenia Africana* in A.W.P.A. Creosote ex Iscor (Heartwood)	—	—	8·29	11·05	9·62	9	9	100	—	—	—	—	—	—	—
21	do.	*Sarcocephalus diderrichii* in A.W.P.A. Creosote ex Iscor (Heartwood)	—	—	10·12	16·57	12·83	18	18	100	—	—	—	—	—	—	—
22	do.	*Euc. paniculata*—Untreated (Heartwood)	—	—	—	—	—	16	16	100	—	—	—	—	—	—	—
23	do.	*Euc. citriodora*—Untreated (Heartwood)	—	—	—	—	—	16	16	100	—	—	—	—	—	—	—
24	do.	*Ocotea rodiaei*—Untreated (Heartwood)	—	—	—	—	—	8	8	100	—	—	—	—	—	—	—

"a" Specimens first impregnated with Copper Sulphate and allowed to dry, then impregnated with Sodium Pentachlorophenate and allowed to dry and lastly with A.W.P.A. Creosote ex Isor.

"c" Specimens first impregnated with Copper Sulphate and allowed to dry and then lastly with Sodium Pentachlorophenate.

"x" Denotes type of attack.

Marine Exposure Test— *continued*

then recorded against the applicable reference number. Cross-sectional deterioration at the point of deepest radial penetration of the particular type of deterioration was taken as the criterion of failure.

Results

From the results obtained in the initial stages of this and other experiments, it has become clear that the chemicals under test are ineffectual deterrents to the ravages of most destructive agencies and of marine animals when applied by brush or other superficial means. It has likewise been established that protection in this respect is a matter dependent not only on chemical composition, but also penetration and net retention. Brush-treated specimens exposed at the start of the experiment have accordingly not been included in Table I.

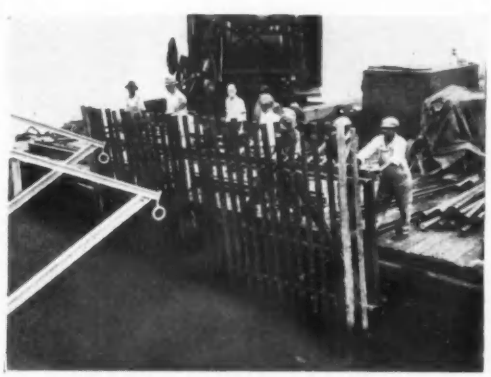
The criterion of efficacy of all the preservatives listed in Tables I and II will be taken as the average life of all the specimens used in each test or group, that life being regarded as a reaction to the average absorptions and penetrations.

Owing to the losses of specimens from the frames and to certain flaws in the design of the pilot experiment, it has not been possible to determine absolute limits of efficacy and non-efficacy. In considering the results obtained with these preservatives the absorptions reported and the suitability of the preservative for 'Marine' purposes must be kept in mind. A wood preservative should not be condemned for all purposes because it failed under Marine conditions[4]. Nevertheless, the results do give a rough picture of the comparative resistance of the chemicals used to the marine wood destroying organisms and have proved a valuable guide in designing the experiments initiated in March, 1957, as set out in Table II of this paper.

In interpreting the Tables due cognisance should be taken of the footnotes. While there was hardly any evidence of attack during the first year of exposure in the chemically impregnated specimens, all the untreated controls were severely attacked after six months of exposure and were completely destroyed after only twelve months. From Table I it would appear thus far that the addition of copper-naphthenate to creosote does not increase its resistance to the attack of *Limnoria* and *Martesia*. Fortifying creosote with pentachlorophenol appears to improve its efficacy.

Creosote plus copper-pentachlorophenate thus far appears to be superior to the three mentioned above. Copper-pentachlorophenate alone does not appear to be as effective as 'Celcure,' and 'Celcure' does not appear to be as effective as some of the preservatives mentioned above (it should be noted here that this is not the improved 'Celcure' 'A'). The creosote plus oil plus pentachlorophenol mixture apears to be less effective than any preservatives previously mentioned. Next in efficacy comes creosote: coal-tar 60:40 mixture and creosote fortified with Nostrip. In no instance was creosote attacked by shipworm. In all cases where copper-pentachlorophenate was present, the specimens were attacked only by *Limnoria*.

Close-up of steel frame with some specimens attached.



Specimens fixed in place by wiring: about to be suspended by chains to brackets attached to Dolphin.

General view of Kruisfontein field exposure test plot (fungi).

The Second Series of Experiments (1957)

In this series of tests which consists of some repetitions of the original series, two comparatively new types of wood preservative a creosote ex Sasol and two copper-chrome-arsenates are under test. The English, Scotch and Swedish formulations of this preservative are thus far standing up very well against termites and decay under field exposue test conditions in South Africa.

It will be noted towards the bottom of Table II, that the creosoted heartwood of three species of wood, *Dipterocarpus spp., Piptadenia africana* and *Sarcocephalus diderrichii* are under test. Since the heartwood of these species is amenable to impregnation with creosote, the results of these particular tests should be of value to those who prefer to use square piling and to build in square cross-section. These species are known to be non- to moderately durable and it was unfortunate that, in the end, untreated controls were not available. The sapwood of both *Eucalyptus citriodora* and *Eucalyptus paniculata* are amenable to impregnation, but in the round these species are prone to splitting. If it were thus found that the heartwood of either or both were durable, the quantities of these trees available in this country, could, if creosoted, be used to great advantage, there being little other satisfactory economic use for them.

Biological Survey

As the experiments progressed in Durban Harbour, it was realized that there was very little accurate knowledge of species of marine wood borers and their capacity for destruction in the various South African Harbours; little or no literature is available regarding distribution of species and the relative amount of damage caused by them. In order to obtain these data and to determine whether Durban was in fact the best place to conduct the main investigations, a biological survey was planned.

Untreated poles of *Pinus patula* were exposed, within a day or two of each other, in every harbour under the control of the South African Railways Administration. After six months all were lifted for inspection and the collection of specimens. It has been confirmed that marine borer activity diminishes as the temperature of the water decreases. The Cape Town Laboratories of the Division of Fisheries gave valuable assistance in identifying the various types of marine borers collected, and provided reliably labelled specimens of each for reference. As a result of this survey it has been established that at least six species of marine borers occur in South African waters, viz:—

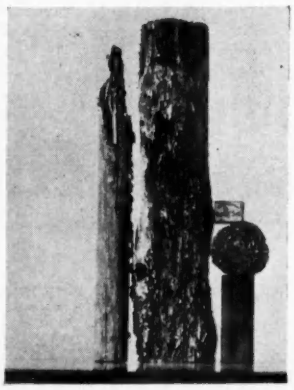
Chelura terebrans (Philippi), *Limnoria lignorum* (Rathke), *Martesia striata* (Linné), *Sphaeroma terebrans* (Bate), *Teredo navalis* (Linné) and *Xylotria capensis*.

All of them are encountered in Durban Harbour although it

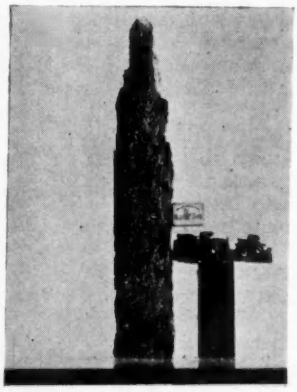
Marine Exposure Test—continued

would appear that only four, *Limnoria lignorum, Martesia striata, Teredo navalis* and *Xylotria capensis* appear to be sufficiently prevalent to be of economic significance.

The Shipworms (*Teredo* and *Xylotria*), appear to be the most widespread and were found to be present in all the harbours with the exception of Walvisbaai, where the high sulphur content in the sea water is thought to be accountable for its absence. *Limnoria* was found to occur only on the East Coast of South Africa, while *Martesia* has been found only in Durban Harbour. These borers have the characteristic of occurring in zones clearly related to the tidal levels; the Shipworms and more often than not *Limnoria* were found to damage particularly the lower third of the specimens while *Martesia* appeared to confine itself to mid-tide level where it, too, caused heavy damage.



Typical Teredo attack.



Typical Limnoria and Martesia attack (section of specimen photographed upside-down).

In order to determine what occurs well below the tidal range in Durban Harbour extra long untreated *Pinus patula* poles are being prepared for placing in deep water so that their top sections will span the tidal range but with their lower ends extending to the bottom if possible.

Conclusion

Although the work has already produced much useful information regarding the relative merits of the various preservatives under test, the conclusion is reached that no definite opinion regarding the effcacy of any one of them can be expressed until the whole series of experiments at present being conducted in the waters of Durban Harbour is completed. Only then can a final analysis be made.

REFERENCES

1. Committee on the Protection of Building Timbers: The Chemical Impregnation of Timber in South Africa, C.S.I.R. Pretoria, 1950, pp. 165-166.
2. Scott, M. H. and Stephens, R. P.: The Quality of Mature *Pinus patula* and *P. insignis* Timber Grown in Africa.
3. Hunt, G. M. and Garratt, G. A.: Wood Preservation, the McGraw-Hill Book Company, Inc., New York and London 1938.
4. Krogh, P. M. D.: A Universal Rating for Wood Preservatives for Common Purposes. Commonwealth Forestry Conference, Canada, 1952.

Manufacturer's Announcements

Protective Coating for Metal and Concrete Surfaces

A new protective coating for metal and concrete surfaces has been developed in the U.K. by Wailes Dove Bitumastic Ltd., Hebburn, Co. Durham. It is said to combine the waterproofing properties of coal-tar-pitch with the resistance to chemical attack and corrosion of epoxy resins. The material is claimed to have excellent adhesion to both metal and concrete surfaces and to be able to withstand exposure to acids, alkalis, oils, fats and many other corrosive chemicals.

At the same time, the coating, which is called "Epimastic," has excellent resistance to abrasion and other forms of mechanical wear, or shock. It can be applied to almost all types of industrial equipment where surface protection is desired, and retains its properties over long periods of time.

Merger of Construction Company and Foundry

The Railway and Civil Engineering firm, Eagre Construction Co. Ltd., of Scunthorpe, has taken over the more than 100-years-old family-owned Isca Foundry Co. Limited, of Newport, Monmouth shire, which manufactures railway materials, switches and crossings, buffer stops, turntables, pressed steel chairs, etc.

Isca will retain its name, and trade as before the take-over, except that extra efforts will be made to increase the flow of the company's products to both home and export markets.

New Dry Powder Extinguisher

Nu-Swift Ltd. announce the introduction of a portable dry powder extinguisher, Model 1630, designed to combat fires involving highly inflammable liquids, live, high voltage electrical equipment, and similar combustable materials. The powder is used in the form of a fan shaped pressure projected spray and is capable of dealing promptly with liquid fires of up to 250 square feet. The extinguisher contains 30 lb. of dry powder, pressurised with eleven ounces of carbon-dioxide capable of expelling the entire contents in 28 seconds. Operational range in still air is approximately 25-ft., with a broad front of 6-ft., and a height of 4-ft. Provision of a two-wheeled, light-weight trolley enables the extinguisher to be moved rapidly.

New Dredger for Harwich

The contract for the provision of a single screw diesel-propelled grab hopper dredger for use at Harwich has been let to the Goole Shipbuilding and Repairing Co. Ltd., Goole. The main engines are to be supplied by Ruston and Hornsby, and the grab crane is to be provided by Priestman Bros. of Hull.

The vessel, which will have the new, raked line associated with modern naval architecture, will have an overall length of 157-ft. 6-in. and a moulded breadth of 34-ft. 6-in. Mr. C. Outhwaite, M.I.N.A., Superintendent, Ship Construction, British Transport Docks, was responsible for the design.

MonoRail Handling Equipment

Standard monorail overhead handling systems are of particular interest to Dock and Harbour Authorities for the handling of maritime cargoes. This method may be employed to move bundles of cargo of various shapes and sizes, up to a maximum weight of two tons, from the square of the hatch to the farthest corner of the holds. In general principle this can be done by one of two ways, either purely manually or mechanically, depending on the type of equipment used.

One application of the system was recently used on two ships, the holds of which were fitted with a series of overhead rails, which were attached to the deck beams at the top of the hold or tweendecks and did not protrude unduly between the bottom of the beams. Before loading commenced the total cargo was broken down into a number of units of equal weight, which were then loaded into the hold by shore side cranes. Once in the hold the units were transferred to the monorail and were then pushed by stevedores to the particular part of the hold where they were to be stored. Unloading the cargo is carried out by reversing the procedure.

Although this process does not provide a complete solution to the problem of mechanisation between the quay and the ship, it does assist the ship's own cargo handling to be self-sufficient, thus increasing her general efficiency and making her less dependent upon the use of shore equipment. Investigations are also being made into the possibilities of using the system to move cargo from transit shed direct to the ship's hold.

The equipment is designed and manufactured by British Mono-Rail Ltd., Brighouse, Yorks.